MACHINERY.

February, 1903.

THE GREAT WEST-ALLIS PLANT

OF THE ALLIS-CHALMERS COMPANY, MILWAUKEE, WIS.

Edwin Reynolds.

THE views accompanying this article were recently taken at the new works of the Allis-Chalmers Co., Milwaukee, Wis., and we think all our readers will be glad of the opportunity to see how this immense plant looks now that it has so nearly reached a state of completion. The present Allis-Chalmers company operate the old E. P. Allis works, Milwaukee, as well as the new works; also the Fraser-Chalmers and the Gates Works, Chicago, the works of the Dickson Manufacturing Co., Scranton, Pa.; and they have absorbed the business of the Lake Erie Engineering Co., Buffalo, and transferred it to their other plants. The Chicago and Scranton plants build the mining machinery contracted for by the company, the latter taking some of the engine work also, leaving the Milwaukee plants free to carry on the bulk of the enormous engine business for which the company is best known to the public. The old E. P. Allis works are to be continued in operation, the same as before the new works were built, the latter serving simply to increase the resources of the company by doubling the capacity of the Milwaukee shops and to afford almost unlimited opportunity for future growth.

The new Milwaukee plant is situated at West Allis, a suburb of Milwaukee, which has the shipping advantages afforded by two railroads and is destined to become an important manufacturing village. Several other manufacturing plants have been located there and many houses are being built. The land controlled by the Allis-Chalmers company is about 100 acres in extent and if the business should become large enough to require all the buildings called for in the original plans, Milwaukee will have one of the largest groups of machine shop buildings in the world. Unlike nearly every other large establishment, however, they will not represent a haphazard growth, with buildings erected to meet present needs, without any particular regard to the future. The whole plan was carefully laid out by Mr. Reynolds, with whose name the accomplishments of the E. P. Allis company are inseparably connected. The floor areas of the machine shop, pattern shop, foundry, erecting shop, etc., as far as erected are carefully proportioned from data secured at the old works and additions to the plant may be made in such a way as always to maintain these ratios, if desired.

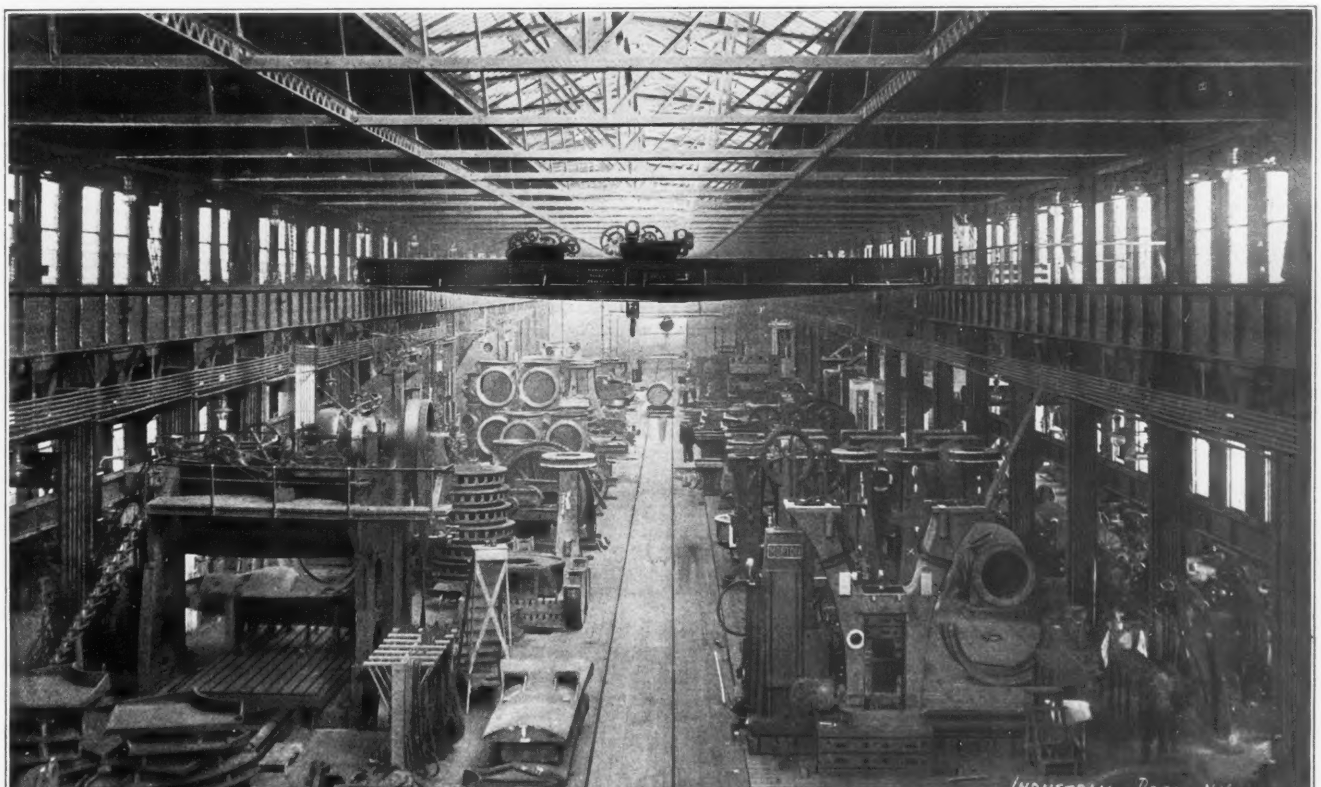


Fig. 1. One End of Machine Shop No. 1 of the West-Allis Plant of the Allis-Chalmers Co. A 10 x 12 Planer appears in the Foreground, and in the Right is a Floorplate 24 x 200 feet, on which Massive Portable Tools are used.

As shown in the ground plan, Fig. 3, the plant is constructed in units, entirely similar in principle (to use an illustration) to the unit system of filing cabinets and book cases now so generally employed in business offices. One complete unit has now been built and consists of a pattern shop and storage building, foundry, machine shops, power house, blacksmith shop, erecting shop, and yard storage, with cranes, tracks, etc. This unit consists of three buildings, the pattern

shop, foundry, and erecting shop, which may be extended northward indefinitely, as indicated by the heavy dotted lines, and of three smaller buildings for machine shop and blacksmith shop purposes extending east and west.

These smaller buildings, and their proportionate parts of the larger buildings, really subdivide the main unit into three sections, and in making additions the shops may be

Fig. 2. Foundry Yard—Pattern Shop on the Left, Foundry on the Right.

extended to include one, two, three or more of these sections, as required; but in any case it will be possible to preserve the balance between the pattern and foundry work and the machine shop work.

Entering the works from the office indicated at the lower left-hand corner of the plan, the first building to be reached is the pattern shop and the pattern storage building, between which and the foundry is yard room for the storage of pig iron and coke and other supplies for the foundry. A view of this yard is shown in Fig. 2, and it will be noted that it is served by a traveling crane, supported by runways on columns. The material is brought to the yard on cars on a standard railroad track—part of an elaborate system of tracks extended through the different departments and to different sections of the yard on which the Company operate their own locomotives.

The pattern shop and storage building, as already stated, is one of the three buildings extending north and south, and which in the event of the enlargement of the works will be lengthened as much as required. The part of the building utilized for pattern storage is four stories high, with concrete floors supported by steel construction carefully protected by fireproof material. The part used as pattern shop is next to the foundry and is only one story high, giving excellent light over the whole floor area. Two views of this building appear in Fig. 5. That in the upper left-hand corner shows the pattern storage section and indicates the proportions of the structure, while that in the lower right-hand corner shows the pattern shop and part of the runway for the traveling crane mentioned above in connection with the foundry yard.

The next building to be reached is the foundry—another of the three structures running north and south. This is the building which appears at the center in Fig. 4. It is 220 feet wide, of the same length as the pattern building, and is divided into three bays, the center bay being higher than the two outside bays or wings, after the usual custom in such buildings, so as to admit side light through windows at the top. The foundry is equipped with three cupolas and approved apparatus is provided to facilitate charging with the proper mixtures of iron and coke. The traveling crane collects the material and brings it to the base of the inclined tracks shown in Fig. 6, where it is transferred by jib cranes to hydraulically-operated cars which convey it up the inclines to the charging floor above. The complete scheme embraces a pair of scales suspended from the hook of the traveling crane by which the pig or scrap iron

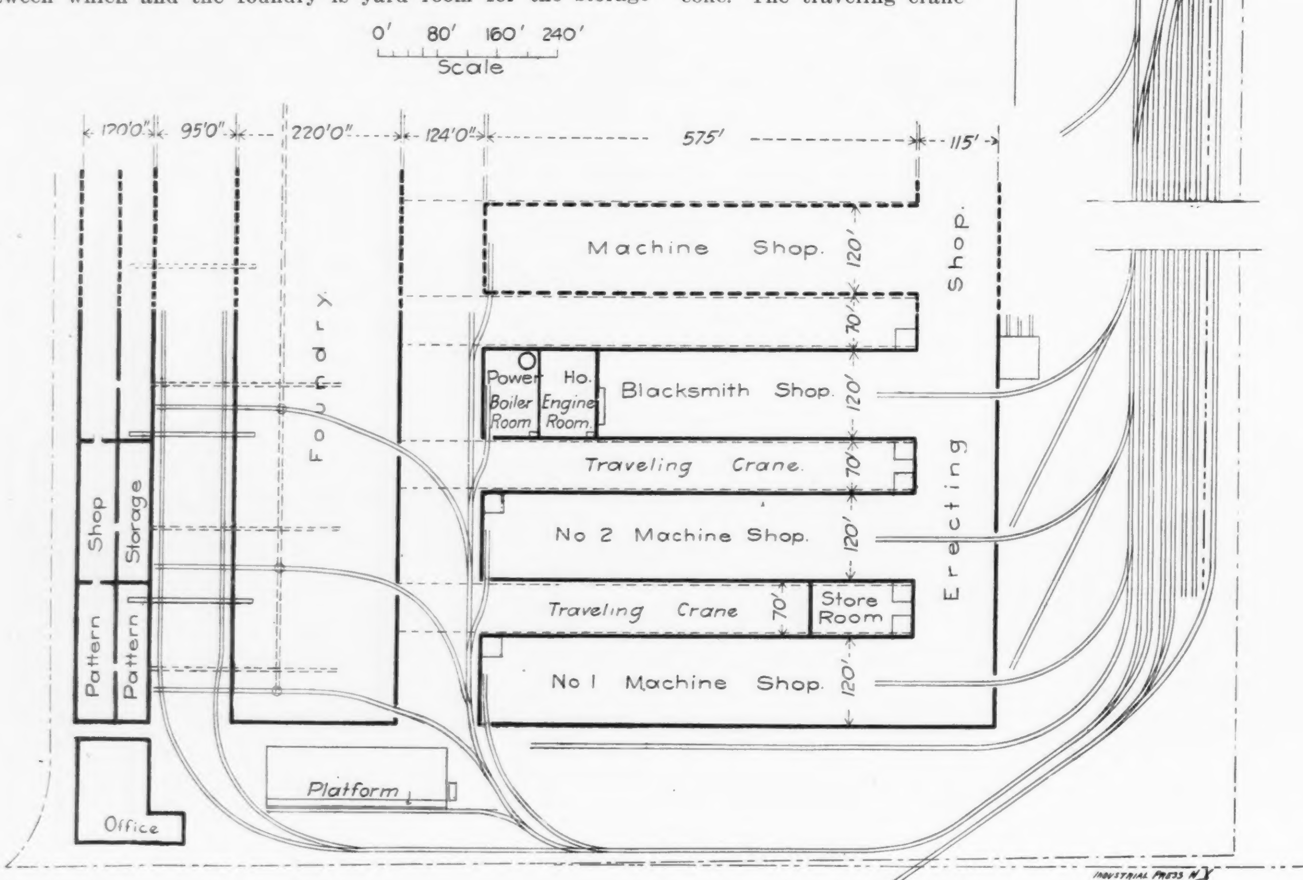


Fig. 3. Plan of the new Allis-Chalmers Plant.

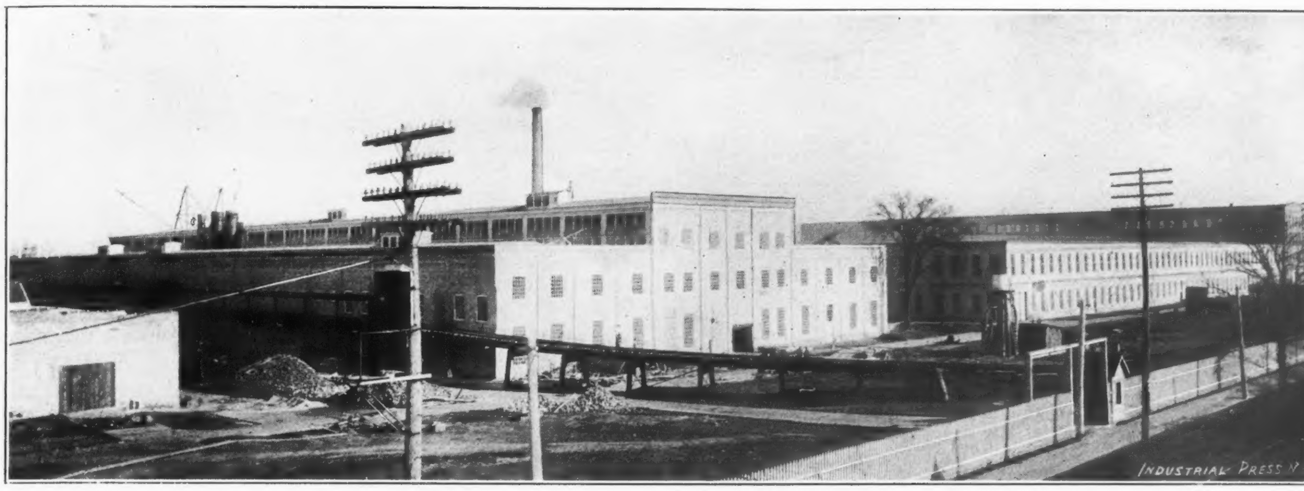
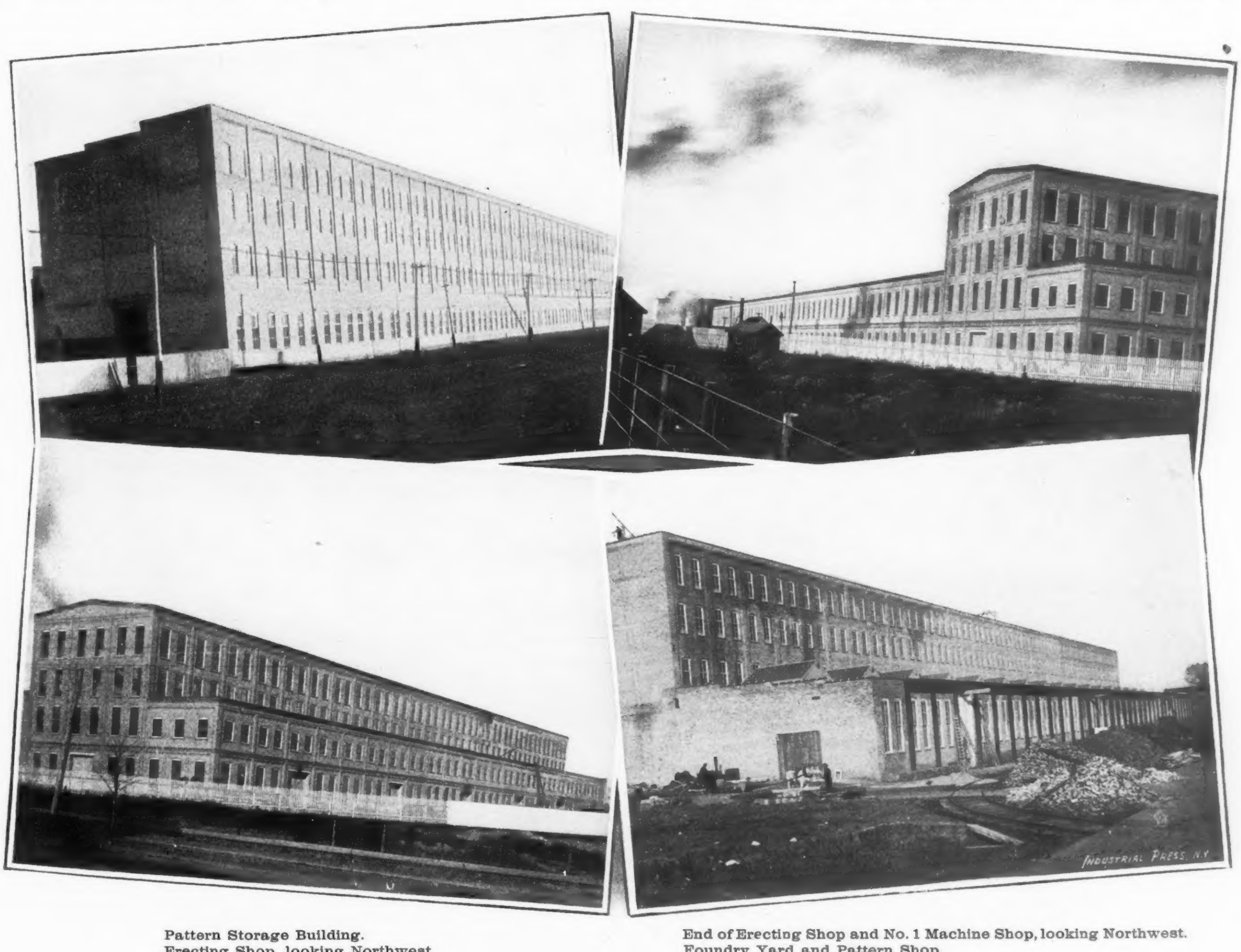


Fig. 4. General View of the New Works, looking Northeast. The Building in the Center is the Foundry. On the Right is Machine Shop No. 1, connecting with the Erecting Shop at its further end.

can be weighed before being deposited at the base of the inclines.

It has already been mentioned that the foundry yard is served by a railroad track, but to facilitate the disposal of sand and other material within the foundry itself there is also an elevated track, indicated clearly in the general view, Fig. 4, and which runs adjacent to the foundry one side of the building. Supplies of sand or other material are drawn up onto this track and discharged into bins provided for them, without further handling.



Pattern Storage Building.
Erecting Shop, looking Northwest.

End of Erecting Shop and No. 1 Machine Shop, looking Northwest.
Foundry Yard and Pattern Shop.

Fig. 5.

Next in order are the three buildings running east and west—two of which serve the purpose of machine shops and the third as a powerhouse and blacksmith shop. Beyond and communicating with these is the erecting shop shown in the lower left-hand view in Fig. 5. One end of it also appears in the upper right-hand view of this group, and in the distance is the No. 1 machine shop which adjoins it. Each of the machine shops and the blacksmith shop is 120 feet wide and 575 feet long. Shop No. 1 has a central crane span of 67 feet with two cranes of 80,000 pounds capacity. The sides are constructed on the gallery system and have auxiliary cranes of 20,000 pounds capacity. An interior view of this building is shown in Fig. 1. In shops Nos. 2 and 3 we believe the crane equipment is somewhat different, being adapted in each case to the class of work to be done. Most of the heaviest machine work is done in shop No. 1, which contains several unusually massive and striking machine tools. The main feature of the building is a floorplate 24 feet wide by 200 feet long, embedded in a substantial concrete foundation and equipped with several very massive tools of semi-portable character for machining the heavy frames and other engine parts that can be more conveniently

and quickly handled by the floorplate system than by any other method.

The construction of this floorplate is the result of much study, and it is believed to be so substantial that it will

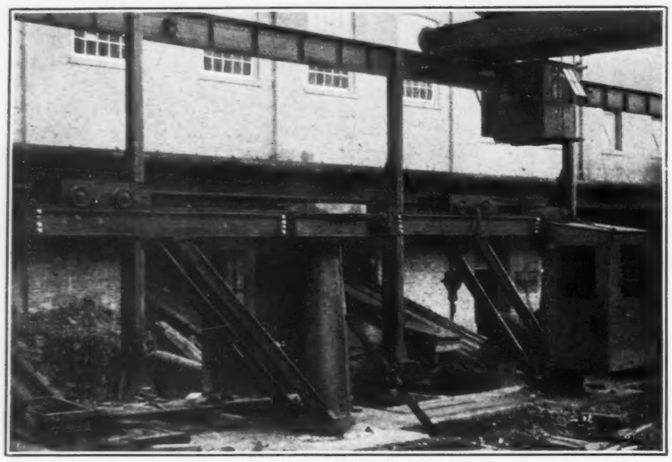


Fig. 6. Jib Cranes and Inclines used in Charging Foundry Cupolas.

stay in alignment a long time. There is ample provision, however, for adjustment, should it get out of level. The floorplate is built up of deep cast-iron sections 24 feet long by 8 feet wide, heavily ribbed and having T-slots for clamping tools or work. At intervals there are depressions in the upper top surface of the floorplate, for accommodating the projecting ends of foundation bolts and their nuts, and also the heads of the adjusting screws which, in each case, are placed beside the foundation bolts. These adjusting screws extend through the floorplate and bear against a small cast-iron plate embedded in the concrete, so that by slackening on the foundation bolt and turning the adjusting bolt the plate can be raised or lowered to bring it into adjustment; then, when the nut on the foundation bolt is again tightened the plate will be held solidly through the binding or clamping of the two bolts. After adjusting the sections of the plates in this way and leveling them, they are grouted in with cement.

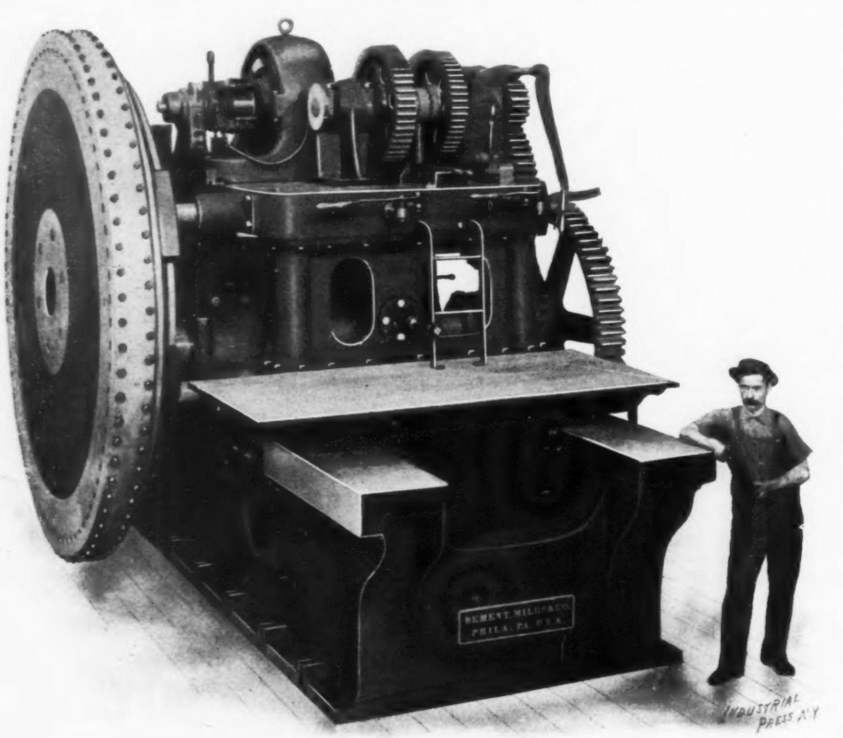
The machine tool equipment of the floorplate is a remarkable collection of tools and indicates a disposition on the part of the management to provide every facility for turning out the heaviest class of work economically and accurately. Among other floorplate tools are two large Morton traveling shapers, 48x48x72 inches and one 72 inches by 72 inches by 11 feet, the latter being the largest shaper of this type ever built. The ram of this machine is of steel, cast hollow, 10x12 inches in cross section. The length of stroke is 72 inches, the saddle carrying the ram will feed vertically on its supporting column a distance of 6 feet, and this column in turn will feed on the bed of the machine 11 feet. The saddle is counterbalanced by an air cylinder on the rear of the column, furnished with pressure by a small compressor, motor-driven. The machine also has a milling attachment whose arbor is 6 inches in diameter, and may be used either for boring or milling, and which carries a 12-inch mill on its outer end. As in all Morton shapers this machine works with a draw cut.

The most striking tools on the floorplate are a pair of 10-foot rotary planers built in the Bement-Miles shops in Philadelphia and which are the heaviest and largest tools of the kind we have seen. A view of one of them appears in Fig. 8. The cutter heads of the planers face each other and one of the machines will ordinarily remain in a fixed position while the other can be adjusted so as to take in work of greater or less length or width between the cutter heads. The movable machine is provided with rollers and is so designed that it can be raised off the foundation and supported by these rollers to facilitate moving along the floorplate, thus bringing it approximately to the correct position. The final adjustment is

Fig. 7. Showing Runways for Traveling Cranes which Operate between the Machine Shops.

obtained by an endwise movement of the main spindle of either planer which can be adjusted out or in a distance of 7 inches. The following specifications of the machine were kindly furnished us by the builders. The saddle has a traverse of 16 feet on a bed 26 feet long. The faceplate is 10 feet 7 inches outside diameter and holds 75 cutting tools. There are three cutting speeds—of 22, 30 and 40 feet per minute, with feeds of 2, 4 and 8 inches per revolution, or an equivalent of 10 inches per minute at 40 feet cutting speed. A moment's thought on the part of the reader will show what this means in the way of rapid surfacing by comparison with the usual methods of removing stock. All of the gearing and clutches are mounted on a platform and are controlled by levers within reach of the operator, who need not change his position at all. For heavy surfacing, provision is made for backing up the periphery of the faceplate by means of adjustable slides that can be brought solidly against its inner surface.

Of the other interesting tools in this shop may be mentioned a 12x10 and a 10x10 planer, the former planing work 30 feet long, and two large boring mills, one 12x12 and the other 12x14, furnished by the Niles-Bement Pond Co. The largest planer appears in the foreground in Fig. 1. There is also a port boring machine of somewhat unusual



One of two 10-foot Rotary Planers in use on the Floor Plate of Machine Shop No. 1.

construction, built by the Grant Tool Co., Franklin, Pa. This was described in the June, 1902, number of MACHINERY.

The galleries of this building and of machine shop No. 2 are equipped with a great variety of smaller tools, furnished by different builders, which we will not undertake to enumerate; though it may be mentioned that a conspicuous installation is the large number of lathes furnished by the Lodge & Shipley Machine Tool Co. An interesting device in shop No. 2 is a dashpot-testing apparatus by which the valve gear mechanism of an engine can be run for any length of time and up to any speed. It is interesting to note also that the dashpots and similar engine parts are made on turret lathes, being turned out in quantities just as are the small parts of any machine which is manufactured by modern methods.

In the blacksmith shop there are, at present, four steam hammers, the largest being of 12,000 pounds capacity. Oil burners are used for the heating furnaces. On the outer end of this building, room has been left for the installation of the power plant, and at the time of the writer's visit one unit was running, and others were in process of erection. The engines are to be of the Reynolds-Corliss vertical type and there will be one unit of 100 K.W., one of 350 K.W., and one of 500 K.W. capacity. There is room here for two more 500 K.W. units, to meet future requirements. Both Westinghouse and Crocker-Wheeler generators are used and the Bullock multiple voltage system is employed for the distribution of the current in the works. The crane equipment throughout the plant is by Pawling & Harnischfeger, Milwaukee.

Continuing now to the erecting shop we find a building running north and south, 115 feet wide by nearly 560 feet long, arranged in two bays, one of which has 60 feet head room under the crane hook, served by a 75-ton crane. A 40-ton crane will be installed later. This section of the shop will be for assembling vertical engines, pumping engines, etc., which can be completely erected here before shipment. The other bay of the shop has 25 feet head room under the crane hook and will be used for the collecting of parts before they are needed for the erecting floor, and for shipping. The general design of the erecting shop and its relation to the machine shops which connect with it will be evident from the upper right-hand view in Fig. 5.

The first essential in an erecting shop is a substantial floor, and this has been secured by laying two feet of solid concrete on top of the clay soil which serves as foundation for all the buildings. Oak stringers were embedded in the concrete and leveled by the aid of a transit and grouted in. On these stringers a heavy plank flooring was laid.

The track and yard arrangements of the West Allis plant are complete in every respect. Connection is to be had with the Chicago, Milwaukee and St. Paul Ry. at the north, and with the Chicago and Northwestern Railway at the south.

Ranged on the easterly side of the yard are the tracks for the reception and shipment of freight, with spur tracks running into the erecting shop and to other sections of the yard. As represented in the drawing, Fig. 2, there is a break in the continuity of the tracks, this being done in making the sketch, because it was desired to show the arrangement of the upper or northerly switches, which in reality are beyond the limits indicated by the drawing. The switches are so placed that two tracks are open to the C. M. and St. P. Ry. for shipment or delivery, and two to the C. & N. W. Ry. for the same purpose. One of the tracks, in each case, is to be used solely for cars that are being loaded for shipment, and the other for cars containing freight to be delivered. This plan will reduce to a minimum the amount of switching to be done.

Beginning at the right, the first track is to be used for connecting the two railway systems. The next two are the shipping and receiving tracks for the C. M. & St. P.; the next two are for the C. & N. W.; and the next three are tracks through which connection may be had with the shops, foundry, and all the various departments of the works. To reach these tracks, however, by either railroad system, it is necessary that cars should pass over the single track at the north part of the yard, where the scales are situated, as indicated on the plan, thus ensuring that no supplies shall enter any part of the works without first being weighed and checked.

The yard crane equipment is no less complete than the railroad facilities. The crane arrangement between the pattern shop and foundry has already been described. There are traveling cranes similarly arranged between machine shops No. 1 and 2 and between the latter and the blacksmith shop, the runways for these extending across the yard space between the easterly ends of these shops and the foundry. In Fig. 7 the ends of these three buildings appear, and the crane tracks and one of the cranes are clearly visible. In the distance is the stack of the power plant.

It is a fortunate and pleasing circumstance in the life of Mr. Reynolds that he has lived to see the culmination of his efforts in the design and completion of this plant. He is over 70 years of age and his life has been marked by aggressive and original work in various branches of constructive engineering. Before going to Milwaukee he was prominently connected with the Geo. H. Corliss engine works, Providence, R. I., which, under the direction of their founder, became the leading works of their kind in the world. When Mr. Reynolds went to Milwaukee the E. P. Allis Co. were far from flourishing; but he has succeeded in doing with this concern in the West what Mr. Corliss did so long ago in the East; only on a more magnificent scale, and with the most elaborate plans for the future ever projected in the engine business.

* * *

MUM'S THE WORD.

A curious tale of machine shop secrecy is told by a New England manufacturer of machines who recently made a trip to Australia and the neighboring islands, including New Zealand, where at Auckland he had the following experience: A local dealer in machinery asked the New England man if he wished to see a remarkable machine, one of which the like was not to be seen in all New Zealand. Of course an affirmative answer was given, whereupon the proprietor of a local jobbing machine shop was approached and asked for the privilege of seeing the machine in his shop. After much argument and a lengthy explanation of the visitor's business, the country from which he came, etc., the privilege was reluctantly granted. A portion of the main workroom had been partitioned off and the door leading into the little room thus made was always kept carefully locked. Even the belt holes were carefully screened so that none of the workmen in the main shop could peek through into the "holy of holies." The proprietor unlocked the door, fearfully ushered his guests within and quickly shut and locked the door behind them. There before them was a machine carefully covered with a tarpaulin which having, with due ceremony, been removed, revealed to the bewildered New England man, a Brown & Sharpe universal milling machine! His astonishment can be imagined; also his embarrassment. He did not know whether to laugh at the matter as a practical joke or to get angry, so made some non-committal remarks and withdrew as soon as he decently could. When once safely away from the shop he took his New Zealand friend to task and asked him why in the name of common sense he had been taken to see a machine with which he was, of course, perfectly familiar. The reply was that he, the New Zealander, wished to give the New Englander a practical demonstration of the difficulties which he met in selling new machinery. The proprietor of this shop had been enterprising enough to buy a milling machine and he did not propose that any of his rivals in business should get a glimpse of the machine or know anything about it. The proprietor had unboxed and set up the machine alone, and did all the jobbing work that came within its range. If the visitor had been from New Zealand or the neighboring island of Australia, he would have not been permitted to see it. So the dealer in machinery was unable to take prospective customers to this shop and there visually demonstrate to them the great advantages of the, to them, new machine.

SHOP CONSTRUCTION.—5.

FLOORS.

OSCAR E. PERRIGO.

In the construction of modern manufacturing buildings there are many methods of constructing a floor, varying all the way from the almost primitive "dirt floor" of the forge shop to the close-jointed smoothly-finished hardwood floor of the modern watch factory. Those which principally concern us in these articles, however, are such as are necessary in the modern machine shop, forge shop, iron foundry, etc., and these we may properly divide into six classes, viz:

First, those composed exclusively of earth, as the floor of the forge shop. Second, those composed of earth and concrete, like the floor of an iron foundry, as shown in vertical section in Fig. 1. Third, those of stone and concrete, as the main or ground floor of a machine shop designed for constructing and erecting heavy machinery, shown in Fig. 2. Fourth, those composed of stone or bricks, as required for engine and boiler rooms, etc., shown in plan in Figs. 3 and 4. Fifth, those of wood, supported by iron beams, as illustrated in vertical section in Figs. 5 and 6. Sixth, those composed entirely of wood, as shown in Fig. 7.

There are also certain conditions which will, in a great measure, determine the kind of floor to be adopted, as, for instance, the situation, the kind of work to be done and the weights which the floor will have to support. As to materials, there are those of each kind which it might be perfectly proper to use in other portions of the work of construction, but which would be objectionable in a floor. Stone should be of such nature and quality as to remain firm and hard, with no disposition to crumble away. Hence granite is the best, although there are other kinds which are nearly as good for certain purposes, and much cheaper. Generally, such as can be obtained near the work are used, to avoid the cost of transportation.

For paving, a hard, smooth-surfaced stone is needed. Sandstone wears away easily, and, therefore the harder varieties are preferable. Slate makes a very smooth-wearing and satisfactory floor. Granite is not usually employed for this purpose owing to the expense of obtaining it and the cost of

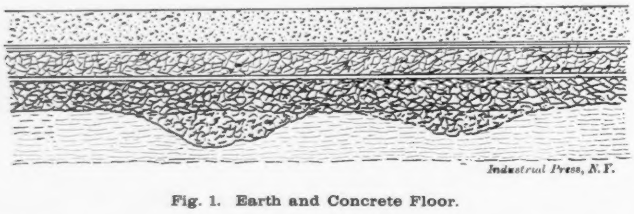


Fig. 1. Earth and Concrete Floor.

cutting. Paving bricks should be hard-burned and of a quality to insure toughness, so that they may not be easily broken by accident. Many brick companies, in different parts of the country, now manufacture bricks for street paving which possess as good wearing qualities as most kinds of stone. Gravel should be free from soil, although a moderate quantity of sharp sand is not objectionable. When earth is used in making a floor a certain amount of clay should be added, to give an adhesive quality to the mass. Sand should be clean and sharp, free from soils and alluvial earth, and not too fine.

Lumber should be so cut at the mill that the grain of the wood shall run as nearly as possible at right angles to the face of the board or plank, as shown in Fig. 9, rather than with the grain running in a direction nearly parallel with the face, as in Fig. 10. The reason for this is that the surface of the planks shown in Fig. 9 will wear smoothly even under very hard usage, while in the other case it will easily splinter up and present a very unsightly appearance, and will not last more than half as long as when properly cut from the log. Then, too, while the plank shown in Fig. 9 will warp very little, if any, that in Fig. 10 has a great tendency to warp, owing to the direction of the grain, and to the fact that the sap or outer portion of a log, being the newer growth, is less dense and consequently will contract more in the process of seasoning. Therefore the tendency is to distort the plank to the form shown by dotted lines in Fig. 10. Logs are usually cut up at the mill on the lines shown in Fig. 11. The boards taken off at the right and left, called "sidings," are trimmed on their edges separately and sold at a reduced rate, while the remaining center portion of the log is cut into stock boards, or planks of regular width and thickness.

To preserve the direction of the grain with relation to the faces of the boards or planks, the form of cutting shown

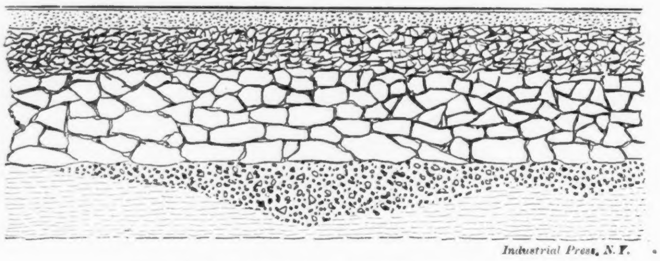


Fig. 2. Stone and Concrete Floor.

in Fig. 12 would be advisable, but not as economical. This latter method is on the principle of quartering, as referred to in the furniture makers' term of "quartered oak," for instance. This form of cutting is shown in Fig. 13. It gives comparatively narrow boards, is expensive, and generally used for expensive woods, and for expensive work, as for fine furniture.

The main, or ground floor of the machine shop being intended to sustain moderately heavy weights, both of machines and materials—as well as the hard usage in moving them from place to place, and the shocks of heavy work—is now usually made of concrete, and laid as shown in Fig. 2. In some cases those portions of floor included in the side wings are constructed of wood. This form is objectionable on account of the obstruction formed by the joining of the concrete floor and the planks; for at this point the former is apt to be cracked and broken, and the latter dented, split and defaced. This is particularly so if the planks are a trifle higher than the concrete, as is likely to be the case when newly laid down. Then, too, where such a floor is of wood it is necessary to excavate a foot or so below the floor timbers, to provide an air space for preventing the decay of the materials.

To lay a concrete floor for this purpose the earth should be excavated to the depth of from 18 to 24 inches, according to the weights which the floor is to carry. For ordinary purposes of machine shop work 22 inches is desirable and sufficient. If the ground is sufficiently firm at this level, no further preparation need be made. If soft and yielding, the excavation should be carried down to solid ground, and then filled up with solid earth, or still better with gravel, the excavation being flooded with water and the filling material thoroughly puddled as it is put in. On top of this bed should be placed a layer of coarsely broken stone, from 8 to 12 inches deep; and upon this a layer of crushed stones, none of which should exceed 2 inches in dimension. This layer should be from 4 to 6 inches thick. On this is spread a layer 2 to 4 inches thick of concrete composed of one part Portland cement, two parts clean, sharp sand, two parts clean gravel, and three parts fine crushed stone—all taken by measure, and not by weight. These ingredients should be mixed rather wet so as to settle well down into the spaces between the stones of the previous course. The concrete should be rammed hard and made perfectly level. Then comes a coating of from ½ to 1 inch thick, consisting of a mixture of one part Portland cement and two parts clean, sharp sand, which

should be laid before the former course is dry, in order that the two courses may firmly unite. This last course is laid quite wet, to facilitate "floating"—that is, the levelling off and smoothing.

Sometimes the intermediate course of concrete work is made up of shingle (coarse gravel, stones, or pebbles), mixed with hot coal tar or Portland cement; but this has the objection that, whatever be the medium used for cementing the mass, it will not adhere to the rounded surfaces of the pebbles as effectively as it does to the more porous surfaces of crushed stone. Therefore, where subjected to hard usage, this shingle is more likely to disintegrate and break up, than where crushed stone is used.

The gallery floors of the machine shop are supported on built-up girders 20 inches deep, placed at each of the columns dividing the wings from the central part of the building. Carried upon angle bars riveted to the girders at a proper height, are the ends of 3x16-inch floor joists, placed 20 inches from center to center, their upper edges coming $2\frac{1}{2}$ inches above the top of the girders, which space is occupied by a spiking piece. On these joists is laid a floor of $2\frac{1}{2}$x6-inch planks, planed on both sides and matched with tongue and groove. This construction is shown in vertical section in Fig. 6. The girders here shown may, of course, be solid I-beams, with angle bars riveted on them for supporting the ends of the joists.

Where a lighter construction may be safely resorted to, on account of less weight to sustain, the form shown in Fig. 5 is proper. In this case an I-beam is used, say 10 to 15 inches deep, and the ends of the joists rest upon the lower flange of the beam. They should be of such depth as to project a couple of inches above the top of the beam, as shown, to provide a

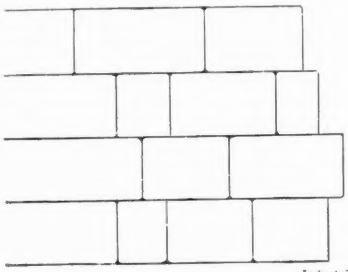
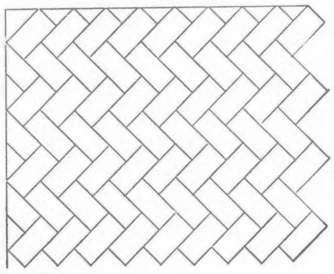


Fig. 3



Industrial Press, N.Y. Fig. 4

Stone or Brick Floors.

space for a spiking piece. In either case the ends of the joists should be beveled as shown, so that they may drop out clear in case of fire, without displacing or warping the I-beams.

Wood joists may be dispensed with altogether, if safety from fire is of more consideration than first cost. In this case I-beams of proper strength are laid upon the girders, or with their ends resting upon the lower flanges thereof—say 4 to 8 feet from center to center—and upon them are laid planed and matched floor planks from 3x6 inches to 5x8 inches, according to the distance between supports and the load to be sustained. These are bolted to the upper flange of the I-beams. This arrangement is shown in Fig. 8. The vertical space occupied by these methods of construction varies considerably, as is shown in the engravings, and must be taken into account in designing the building.

Where it is desired to support floors by wooden beams, the form shown in Fig. 7 is proper. The dimensions of the beams must be sufficient to carry the load, taking into consideration also the distance between supports. The ends of the beams resting in the brick wall should be upon a "header course" of bricks, as shown, and the ends of the beam bevelled off the same as if used in connection with an iron girder or I-beam, so that in case of fire the beam will fall freely out of the wall without injuring it. Floor joists are laid upon the beams in the usual manner and spiked to them. Wooden floor joists should be braced by a "bridging" of, say 2x3-inch scantling, as shown, placed at intervals of from 4 to 8 feet, according to the dimensions of the joists and the weights they have to support.

In using floor planks of 3 inches or over in thickness it will be found more economical to groove both edges of the planks and insert a separate piece as a tongue, than to cut a groove in one edge and a tongue on the other.

The selection of proper lumber for floors has already been referred to. It is often profitable to consider those things that have failed since it has been well said that "we learn as much by one failure as by two successes." And the failures in shop floors are prolific sources of much annoyance and expense. A certain machine shop floor was laid upon round chestnut timbers, flattened on top and bedded in

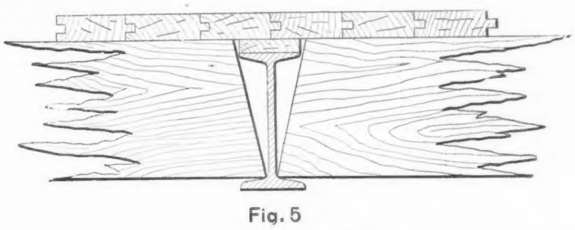
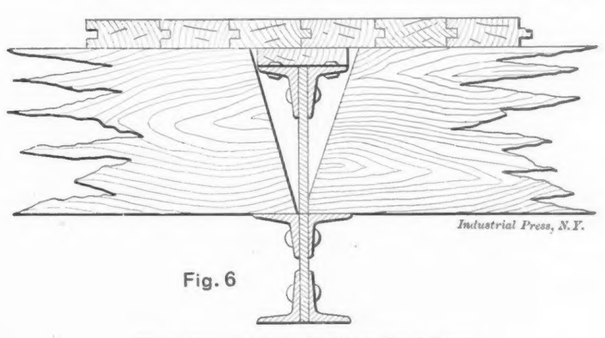


Fig. 5

Floor Supported by I-beam.

gravel laid over "made land," that is, loosely filled in with refuse matter of any sort easy to obtain. The floor proper was of 2-inch spruce planks. The result was that within a year the chestnut timbers and the under side of the planks began to decay, and since that time about one-half of the timbers, and nearly all the floor planks have been replaced each year, the patching-up process going on at intervals, and the result being an unsightly as well as expensive and annoying affair. Within a hundred feet of this floor was another of 2-inch planks laid on 3x12-inch joists, supported on 12x12-inch timbers resting on piers, raising the floor about two feet above the ground. Twelve years after this was laid some planks were removed to put in a machine foundation, and the joists and timbers were found looking nearly as fresh and new as when they came from the lumber yard. Their elevation above the ground and the ventilation of this space by small gratings in the side walls were evidently the cause of their preservation. These cast-iron gratings, say 10x18 inches, should be inserted at least every fifty feet in the walls of buildings whose ground floors are of wood, and at least a foot of ventilating space should be left between the ground and the floor.

Another example, equally instructive, was a second floor of a machine shop. It was of $2\frac{1}{2}$x6-inch spruce planks, properly supported. They were grooved on each edge $\frac{3}{4}$-inch wide and strips were inserted as shown in Fig. 14. The builders evidently thought that planks $2\frac{1}{2}$x6 inches, with inserted tongues, would make a good and substantial floor. And so they would have, but the unfortunate selection of the planks included many with the grain running in the wrong direction, which caused much warping and distortion. Fig. 15 is from a sketch taken at the head of a stairway, careful attention having been given to the direction of the grain



Industrial Press, N.Y.

Fig. 6

Floor Supported by Built-up Steel Beam.

and the distorted form of the planks. It is, perhaps, needless to say that the tongues were split, and in some cases the planks also.

Formerly the timbers most used in ordinary construction were of spruce. While this wood is well adapted for floor planks, it has very serious objections when used as supporting timbers. There is great liability to warp, twist and crack as the seasoning process goes on, while its strength is not as great as some other easily obtained woods. For

instance, hard pine is superior in this respect, while it is about 35 per cent. stronger than spruce, and its usual cost is only about 20 per cent. greater.

The foundry floor is subjected to a very considerable weight, both in molding sand and in the castings produced, but the rough usage and shocks which the machine shop floor is called upon to withstand, are not met with here. Consequently there is no need of such an expensive preparation. The ground is prepared in the same manner as for the machine shop floor, except that it is only 12 inches below the floor line. This space is first covered with a 4-inch layer of crushed stone, over which is poured a thin mixture of one part Portland cement and two parts sand, mixed rather wet. Then a concrete is made of the same mixture and finely crushed stone, and laid to a depth of about 3 inches. On top of this is spread a flowing coat of the cement and sand mixture from ½ to ¾-inch thick, which is properly levelled off. All this having thoroughly set, the remaining portion of about 4 inches is made up of molding sand.

Pits are dug in the central portion of the foundry floor, of such number, area and depth as the contemplated work renders necessary. The bottom is covered with 6 inches of concrete and laid with two courses of hard bricks. The side walls of the pits are 8 inches thick and are built of hard bricks, all laid in cement mortar. The top of the wall is level with the final cement coat of the floor. If castings of ten tons or over in weight, and with comparatively small bases are to be made in one of these pits it will be necessary to put down a more substantial bottom. Excavation should be made to solid ground, or "hard pan," and large stones laid in cement mortar built to within about a foot of what is to be the bottom of the pit. Then proceed as above for making ready for the side walls. Care should be exercised in ramming or puddling, or both, to fill in around the side walls.

The floor of the forge shop is a still more simple matter than that of the foundry. The ground is prepared as before, and levelled off a foot below where the top of the floor is to be. This space is filled in with clean gravel mixed with clay,

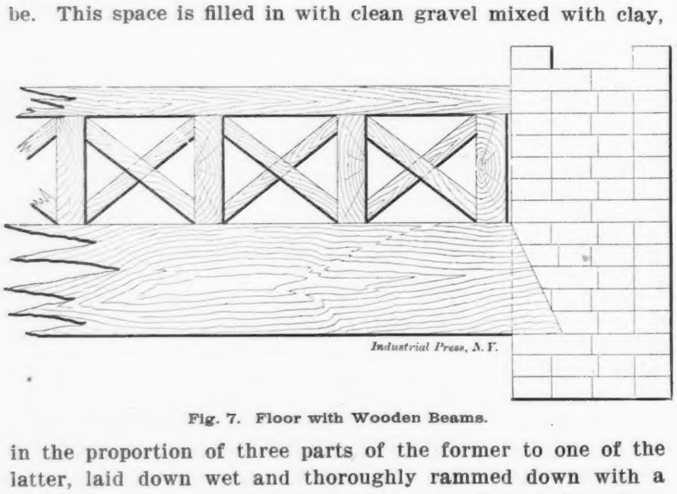


Fig. 7. Floor with Wooden Beams.

in the proportion of three parts of the former to one of the latter, laid down wet and thoroughly rammed down with a broad-faced rammer. Sharp sand, or the fine cinders from forges are sifted over this to prevent the surface from becoming muddy when accidentally wet. In the case of a forge shop, concrete is hardly advisable, being liable to be broken up by the heavy shocks from hammers and the rough usage to which it would be subjected. Of course it might be made thick enough to endure these conditions, but would be quite expensive and would answer the purpose no better than a hard-rammed floor of earth, as above described.

For the floor of the boiler room, flag-stones, or hard-burned bricks may be used, whichever is found most convenient. If stones are used they should be cut to a certain width, in one direction at least, in order that they may be laid in

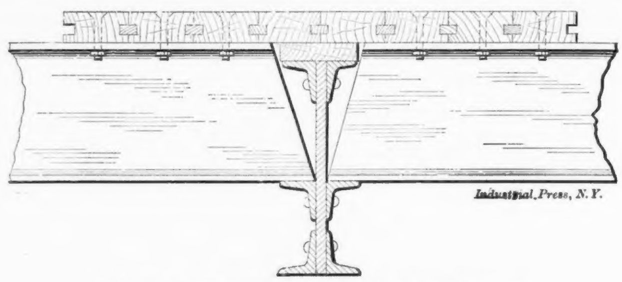


Fig. 8. Floor Supported Entirely by Steel Beams.

courses so as to "break joints," as shown in Fig. 3. They should be from 1½ to 2½ inches thick. Supposing the ground to be sufficiently solid for the purpose, it is prepared by levelling, the same as heretofore described and at least 4 inches plus the thickness of the stones below where the top of the floor is to be. Sharp sand should be filled in 4 inches deep, and the stones laid upon this, the sand being rammed closely under each course as laid. When completed, dry sand to the depth of ½ inch is spread over the whole and swept back and forth to force as much as possible down through the joints. This is the cheaper and more simple method. If it is desired to make a more substantial pavement, the earth should be levelled off at such a height that only an inch space is left between it and the stones, and an inch course of a mixture of one part Portland cement and two parts of sharp sand worked up rather soft. The stones are laid on this while it is wet, and all spaces filled as each course is laid and levelled. Some masons may prefer to make this mixture with a portion of lime added, the same as in cement mortar.

Should bricks be used they may be laid on either the sand or cement bed the same as described for stone, except that about half the depth of sand will be sufficient. They should be arranged in the form shown in Fig. 4, by which method they are firmly bound together, and, if laid only upon sand, will retain their places for a long time. They are in some respects to be preferred to stone. Where the ground is soft or has soft spots, it will be necessary to excavate to comparatively hard ground and then fill in with solid earth—preferably gravel—which is to be tightly rammed or puddled to make it firm. Upon this the layer of sand may be placed as described.

It is sometimes desirable to have engine room floors paved also, and occasionally with much larger and heavier stones than those described above. They should be carefully laid in cement mortar on a good concrete bed. If rolled-iron plates, or cast-iron plates are to be used they should be supported by brick piers and iron bars, or by brick walls supporting their ends, and at other points if their dimensions render it necessary. Cast-iron plates may be made with strengthening ribs on their under side, by which means the supports may be much further apart.

Fig.9

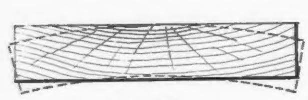


Fig.10

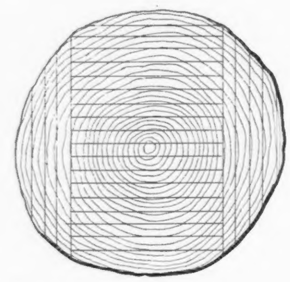


Fig.11

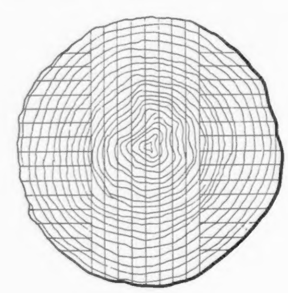


Fig.12

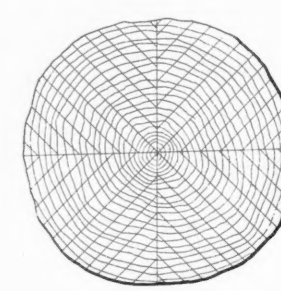


Fig.13

Industrial Press, N. Y.

Methods of Sawing up Timber.

The modern engine room is a much better appointed department than formerly. It should have a floor of narrow, matched hard pine, smoothly levelled off by hand planing, and the surface kept oiled with boiled linseed oil. The floor of the storehouse is of 2-inch planks laid on 3x12-inch joists, placed 15 inches from center to center, which in turn are supported by timbers 10x12 inches, placed 10 feet apart, from center to center and resting on piers, leaving 15 feet between supports. If the load which this floor is to carry warrants it, this distance should be reduced to 10 feet. The floor planks may be matched if desired, but for a floor for heavy machinery storage they need not be either matched

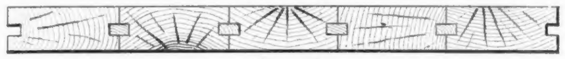


Fig. 14

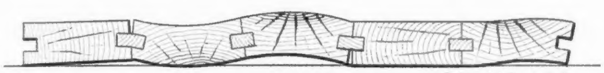


Fig. 15 *Industrial Press, N. Y.*

A Floor that Warped out of Shape.

or planed. The carpenter shop floor is of similar construction to the above except that the joists are 2x10 inches, laid 18 inches from center to center, and supported at distances of 13 feet by 8x10-inch timbers, resting on piers 10 feet apart.

The cupola platform of the foundry is of 2½-inch planks laid on 3x12-inch joists, placed 12 inches from center to center, and supported in their centers by a 10x12-inch beam, whose ends rest in the brick walls, and its center upon an 8x8-inch post. The floor, at least in the vicinity of the cupola, should be protected by sheet iron smoothly nailed down. If preferred, the floor may be constructed entirely of iron. In this case, plate girders or I-beams should carry cross supports and the floor be composed of cast-iron plates reaching from one support to the other, and having supporting ribs cast on their under sides. This form would, of course, make a much better method of construction, and in such a situation, much safer from the danger of fire, although more expensive.

The floors of the washrooms in the power house are of 1½x6-inch matched planks, planed on both sides, and laid on 2x12-inch joists placed 16 inches from center to center.

Floors in the office building, including the drawing room and pattern shop, are laid with a lining of ordinary pine ⅞-inch thick, and covered by 1⅛-inch hard pine, planed and matched, and not over 3½ inches wide, with the grain of the wood as shown in Fig. 9 The floors are laid on 3 x 12-inch joists placed 16 inches from center to center and supported by 10x12-inch beams set 12 feet from center to center. For the second floor these beams are supported on iron columns in the office and on 8x8-inch posts in the tool room, set 16 feet apart, making four posts or columns in the building 50 feet square, outside measurement. The timbers of the ground floor are supported on brick rising from the ground, which is excavated to a depth of at least three feet below the floor. One of these piers is under each post or column. In place of wooden beams and joists, iron or steel girders or I-beams may be introduced, making a construction more nearly fireproof, particularly for the second floor, but adding materially to the expense.

The floor of the pattern storage loft is of 1½-inch matched planks laid on 3 x 12-inch joists placed 16 inches from center to center and supported by I-beams 15 inches deep, one end resting in the front wall and the other on an 18-inch box girder carrying the rear wall and resting on iron columns, as shown in the plan.

As to the kind of lumber used in the floors of manufacturing buildings, spruce is by far the most common, and if properly selected is best for all ordinary purposes. Hard pine makes an excellent floor and is preferable where extra expense is not an obstacle. Occasionally when cost is a secondary consideration, and a perfectly smooth surface is necessary, floors of hard maple are laid and carefully surfaced off by hand-planing. This makes probably the most durable of any of the wood floors.

The writer saw a floor about 125 x 250 feet, prepared with a concrete bed and then laid on the wet flowing coat with hard maple blocks 2-inch x 4-inch x 12-inch laid on edge and in the "herring-bone pattern" shown for bricks in Fig. 4. After the concrete had thoroughly set the surface was hand-planed and oiled. Of whatever kind of wood floors are made the material should be well seasoned, and if shrinkage cracks are to be avoided, the narrower the planks are the better, although three inches may be the minimum width. If they are three inches thick or more, then six inches should be the minimum width.

* * *

CAMMING AUTOMATIC SCREW MACHINES.

EXPLANATION OF PRINCIPLE, AND DEMONSTRATION.

Very little has ever been published on the subject of camming automatic screw machines of the Spencer or Hartford type for the reason, we believe, that the problem has been usually attacked by the "cut-and-try-method" in which "judgment" and the personal experience of the tool-maker doing the camming were the principal factors, calculations being ignored as much as possible. We do not mean by this that the universal practice is to follow this method for, happily, it is not; but the methods pursued by those who handle the problem intelligently have not, with possibly a few exceptions, been given to the public. For this reason we think the following reprint of an article on the subject by W. A. Jeboult

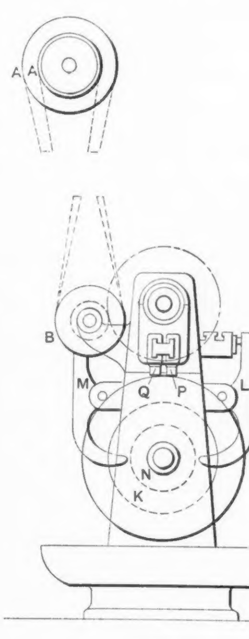
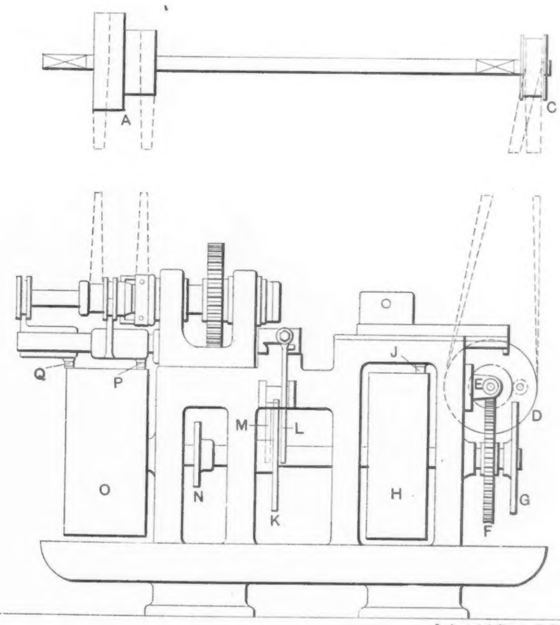


Fig. 2.



Industrial Press, N. Y.

Fig. 1. End and Side Elevation of Screw Machine.

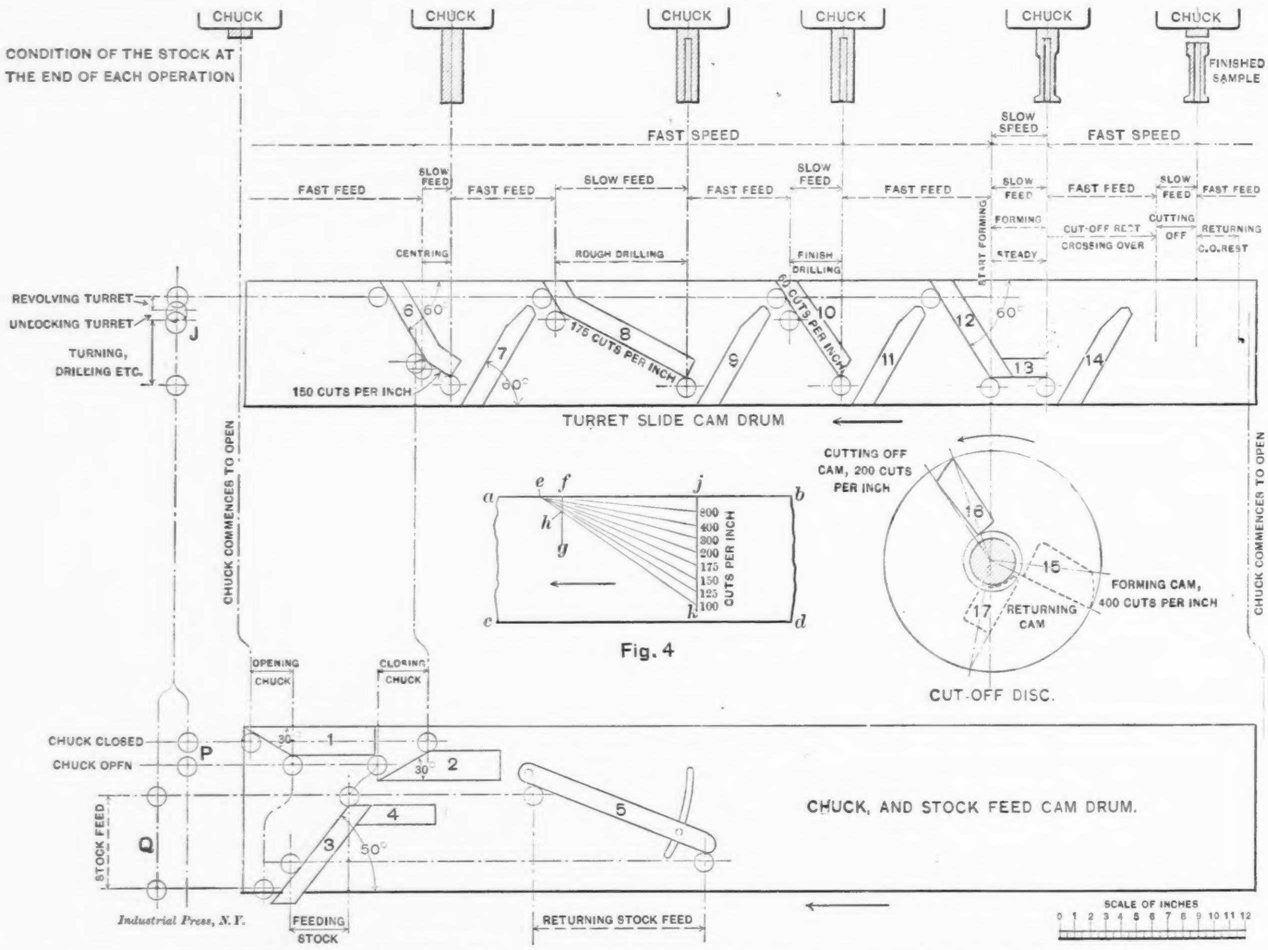
published a few weeks ago in the *Mechanical World* (Manchester), will be found to be of unusual interest. We hope to get something on the same subject from our contributors who may be able to give information of further interest.

Fig. 1 is a side view, and Fig 2 an end view of the machine to which the cams are to be fitted. *A A* are the main driving pulleys on the countershaft. The drum shaft is driven from the countershaft by the feed pulley *C*, thus driving either of a pair of pulleys *D*, which contain a differential gear, and so can drive the worm *E* one revolution for one revolution of the differential gear pulley (the fast feed), or one revolu-

tion of worm E for 60 revolutions of the differential gear pulley (the slow feed), the ratio of the differential gear in this case being 60 to 1. The fast feed is used when bringing the tools, etc., up to the work, unlocking and revolving the turret, also when opening and closing the chuck, feeding the stock, etc.; the slow feed is used when the tools are actually cutting. The worm E drives the worm wheel F, and thus revolves the drum shaft to which the drums and disks are keyed. To the change feed disk G are clamped adjustable dogs, which engage with a pin on the end of a belt-striking lever (not shown), and so shift the belt from the fast feed differential gear pulley to the slow feed differential gear pulley and *vice versa*. The turret slide cam drum H has cams fixed to it, and moves the turret backward or forward by the cams pressing against the bowl (roller) J. As the turret is brought backward, a fixed cam on the turret slide withdraws the locking pin, and as soon as this is effected a lever engages with an indexing ring fixed to the under side of the turret, and so revolves it, thus bringing the next tool into line, the locking pin then being forced in by a spring. The cut-off disk K, to which are fixed the forming and cutting-off cams, etc., works the cut-off rest through the double-ended levers L and M, which are placed one on either side of the disk. The change speed disk N has adjustable dogs clamped to it, which alter the position of the driving belts on the head to fast or slow speed, or forward and reverse, etc., as required. The chuck and stock feed cam drum O has cams fixed to it, which open and close the drawback collet chuck by means of the bowl P, etc.; this drum also takes the cams which work the stock feed by the bowl Q. The following are the particulars required for the case under consideration:

Main driving pulleys A..........	Diameter 12 and 8 inches
Feed pulley C....................	Diameter 7½ inches
Back shaft pulleys B.............	Diameter 9 inches
Ratio of gear in head...........	3 to 1.
Differential gear pulleys..........	Diameter 12 inches
Ratio of differential gears, fast feed	1 to 1.
Ratio of differential gear, slow feed	60 to 1.
Worm E	Single thread
Worm wheel F....................	No. of teeth, 104
Cam drums H and O.............	Diameter 21 inches
Cut-off disk K....................	Diameter 14 inches
Bowls J, P and Q................	Diameter 1¼ inches

We also measure the distance from the edge of the turret-slide cam drum (see Fig. 3, left-hand side) to the farthest "out" and "in" positions of the bowl J, and see at what distance from the edge of the drum the unlocking and revolving of the turret take place. On the chuck and stock feed cam drum we measure the distance from the edge of the drum to the position of the bowl P when the chuck is closed, and again when the chuck is open; also the position of the bowl Q when the stock feed collet is as far forward as it will go. This position had better be taken when the chuck is open. The distance from the edge of the drum to the position of the bowl Q, to give the longest feed of stock that the machine is capable of taking, is also measured. Now, referring to Figs. 1 and 2, the bowl J is on the vertical center line, but it will be seen that the bowls P and Q are not on the vertical center line, but at equal distances on each side of it; this distance should be measured. These positions of bowls can be drawn down to any convenient scale, as shown to the left of Fig. 3. We also draw two rectangles to represent the two cam drums, developed as shown. The chuck and stock feed cams may also be drawn in. To start with, we assume that the chuck is closed, and that the bowl P runs up the cam 1 until the "open" position is reached. We now lay out the position of the stock feed bowl Q to feed the longest amount of stock the machine will feed, and at the same distance between P that there is between P and Q in Fig. 2. We next draw in the stock feed cam 3 just clear of the bowl, to be sure that the chuck is quite open before the stock commences to move. The bowl Q runs up the stock feed cam 3 (which is set at 50 deg.) until the farthest "in" position is reached; then the corresponding position of P can be laid out, and the chuck-closing cam 2 drawn in just clear of the bowl P, which runs up cam 2 and closes the chuck. The retaining cam 4 is to prevent the closing of the chuck from forcing out the stock feed. The stock feed returning cam 5 is adjustable, the amount of stock fed for-



Figs. 3 and 4. Diagram showing Method followed in Laying Out the Cams of Automatic Screw Machines.

ward being regulated by the position in which cam 5 leaves the bowl *Q*. This cam can be put in any convenient position on the drum, but it is advisable to keep all the cams on this drum within half the circumference, so that should a job have to be done on the machine necessitating the chuck and stock feed to be operated twice in one revolution of the cam drum, the extra set of cams could be put on without displacing any already fixed. It should be noticed that in the example the stock feed cam 3 will feed forward the greatest length of stock that the machine will take, although not required in the present case. These cams can therefore be considered as standard for the machine.

The turret slide cams are not quite so simple, and a few calculations must be made previous to starting; also the list of operations and travel of tools settled. The sample under consideration is first to be centered at 150 cuts per inch; then to be rough-drilled at 175 cuts per inch; then finish-drilled at 60 cuts per inch—all these operations being done on the fast speed of the spindle. Then a steady is to run up, and the forming to be done at 400 cuts per inch on the slow speed of spindle, the steady to return, and cutting off to take place at 200 cuts per inch on the fast speed of spindle, thus using all four holes in the turret and maximum travels.

Now construct the diagram of cutting angles of turret slide cams, Fig. 4. It should be noticed that all the machining operations performed by the turret are done when the machine is running at the fast speed and slow feed, so that the diagram is to be constructed for the fast speed and slow feed only. The first thing to know is the number of revolutions made by the spindle when running at the fast speed, for one revolution of the cam drum. This can be obtained from the list of particulars, thus:

Worm wheel *F*, 104 teeth.
Worm *E*, single thread.
Differential gear shaft = 104 revolutions.
Ratio of differential gear, slow feed, 60 to 1.
Differential gear pulley *D* = 104 × 60 = 6240 revolutions.
Differential gear pulley *D* = 12 inches diameter.
Feed pulley *C* = 7½ inches diameter.

$$\text{Countershaft} = \frac{6240 \times 12}{7.5} = 10{,}000 \text{ revolutions.}$$

Main driving pulley *A*, fast speed, 12 inches diameter.
Back shaft pulleys *B*, 9 inches diameter.

$$\text{Back shaft} = \frac{10{,}000 \times 12}{9} = 13{,}333 \text{ revolutions.}$$

Ratio of gear in head, 3 to 1.

$$\text{Revolutions of spindle for one revolution of drum, } \frac{13{,}333}{3} = 4444$$

The diameter of the cam drum is 21 inches, and the circumference is 65.973 inches, so that the number of revolutions made by the spindle for 1 inch circumferential travel of the drum $= \frac{4444}{65.9} = 67.4$. Then the circumferential length of drum to equal 100 revolutions of spindle $= \frac{1 \times 100}{67.4} = 1.48$ inches. Assume *a b c d*, Fig. 4, to be a portion of the turret slide cam drum laid out flat. From *e*, at the distance 1.48 inches, drop the perpendicular *f g*, and *h*, 1 inch down on *f g* measured from the line *a b*, draw a line joining *e*. Now it will be obvious that if a cam is fixed on the drum to coincide with the line *e h*, while the drum moves from *e* to *f* the turret will move from *f* to *h*; and as the distance *e f* is equal to 100 revolutions of the spindle, and *f h* is equal to 1 inch, then the angle *e f h* is the angle for a cam to give 100 cuts per inch. For convenience it is necessary to construct the diagram larger than *e f h*, so we multiply *e f* and *f h* by any suitable number (in the example it is 7, this giving a diagram large enough to work from). To obtain any other number of cuts per inch, it will be noted that 200 is half the length of the line *j k* for 100 cuts per inch; 400 is half the length of the line for 200, and so on.

The turret slide cams can now be proceeded with. Referring to Fig. 3, while the chuck was closing, the cam 6 had carried the bowl *J* nearly up to its work, allowing a little clearance, to be sure the chuck was closed before the centering tool began to cut. The amount of travel on the slow feed for centering having been decided on, the angle of the cam for 150 cuts per inch can be obtained from the diagram, and drawn in. The bowl *J* can then be shown at the end of its travel. It is understood that no cams are to be placed on the drums that would force the bowls further than their extreme positions shown at the left of Fig. 3. The returning cam 7 can next be drawn in, allowing room for the bowl to pass between the cams 6 and 7; the end of cam 7 is taken off to revolve the turret a trifle slower, and bring the turret to rest with less shock; the rough and finish drilling cams can be treated in a similar manner to the centering cam 6.

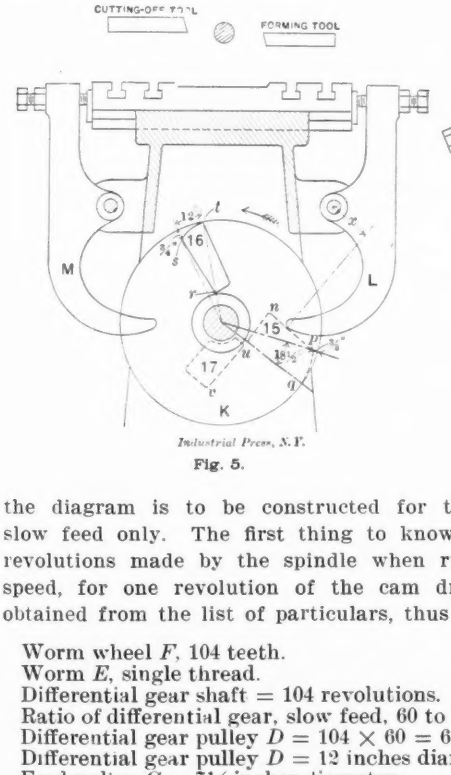


Fig. 5.

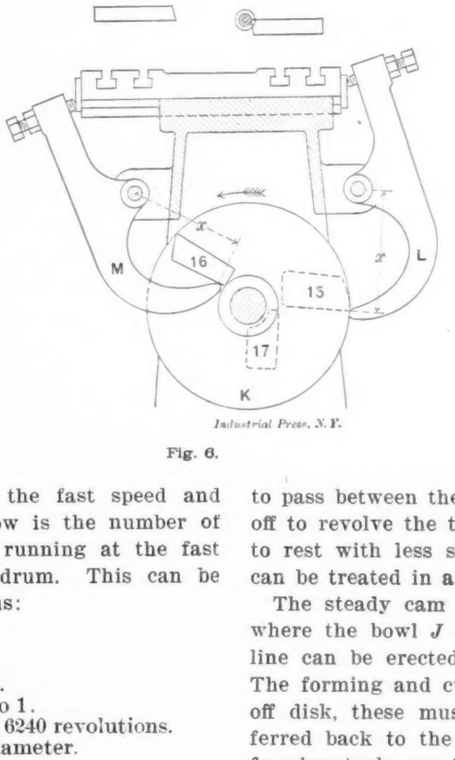


Fig. 6.

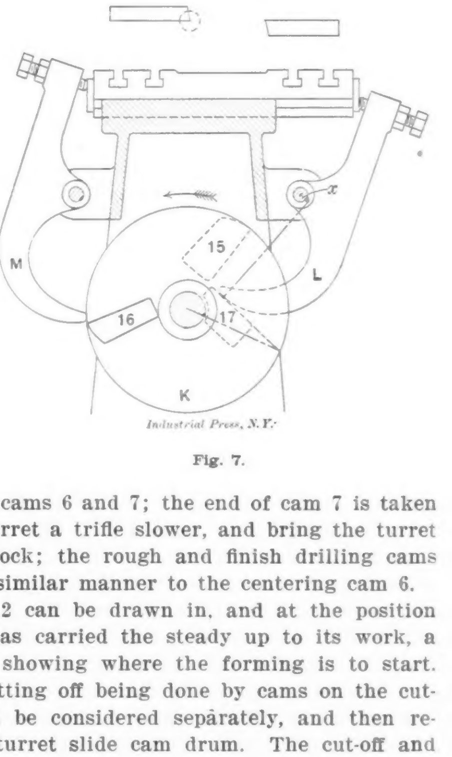


Fig. 7.

The steady cam 12 can be drawn in, and at the position where the bowl *J* has carried the steady up to its work, a line can be erected showing where the forming is to start. The forming and cutting off being done by cams on the cut-off disk, these must be considered separately, and then referred back to the turret slide cam drum. The cut-off and forming tools are to be kept far enough apart when in the mid-position to let the box tools pass between; this is very important on some jobs.

Fig. 5 shows the cut-off rest in mid-position and the forming lever *L* about to run the cut-off rest up to the job; the cut-off and forming levers are the same length on each side of the fulcrum. For the job in hand it is necessary to form ¼-inch deep; to this we add an extra ⅛-inch for contingencies, making ⅜-inch deep at 400 cuts per inch on the slow speed of the spindle. The number of revolutions made by the spindle when on the slow speed for one revolution of the drum is 2,963, which number is obtained by the same method as used for the fast speed. The revolutions of spindle required to form ⅜-inch deep at 400 cuts per inch is $\frac{400 \times 3}{8} = 150$. While the drum makes one revolution or moves through 360 deg., the spindle on the slow speed makes 2,963 revolutions; then the number of degrees moved through

by the drum while the spindle makes 150 revolutions on the slow speed $= \frac{360° \times 150}{2963} = 18.2°$, say $18\frac{1}{2}°$. The portion of the cam 15 is laid out as shown in Fig. 5. The radius for p q, which is the part of the cam used when the forming tool is cutting, is approximately correct if taken as half the diameter of the disk; but in the case of a cam containing a large number of degrees, a correct spiral form should be used to give a uniform cut.

Fig. 6 shows the forming lever L after forming is finished and the cut-off lever M is about to move the cut-off slide across and bring the cut-off tool into action. We leave for the present the portion s t of the cutting-off cam 16, Fig. 5, used when machining takes place. The portion r s of the cam that moves the cut-off rest up to the job quickly had better be considered, and what applies to this cam, equally applies to the portion n p on the forming cam 15, and u v on the returning cam 17. It is usually necessary to move the cut-off rest over the idle portion of its travel for the least possible movement of the disk. In the present case it is necessary to move the cut-off rest after the forming is finished to where the cut-off commences, and again after the cutting is finished to the mid-position, for the least possible movement of disk, and so save a lot of idle or waste space on the turret slide cam drum. In the case of the forming cam it is of less account as there is a lot of space on the drum previous to where the forming starts that is used for returning the finish drill and running down the steady, and this space can be utilized when running the forming tool up to the job. The effective leverage x should be kept as long as possible, but of course the shorter the

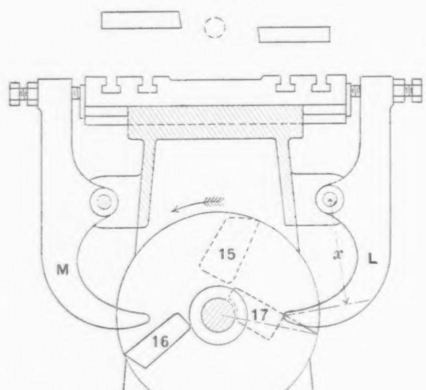


Fig. 8.

effective leverage the quicker the slide moves. Another point to watch when working on these quick portions of the cams is that the opposite lever clears the cam it is leaving.

Having settled that portion of the cutting-off cam 16 that moves the cut-off rest up to the job, the portion s t that is used when machining can be considered. It is required to cut off ⅝-inch deep at 200 cuts per inch; and allowing an extra ⅛-inch, this makes ¾-inch total depth. The number of revolutions of the spindle, when on the fast speed, to one of the drum equals 4,444; the revolutions of spindle to cut off ¾-inch deep at 200 cuts per inch $= \frac{200 \times 3}{4} = 150$. Then using the same method as described for the forming cam, the number of degrees moved through by the drum while the spindle makes 150 turns on the fast speed $= \frac{150}{4444} \times \frac{360°}{1} = 12.1°$, say 12°. This portion of the cam 16 is set out as shown in Fig. 5.

Fig. 7 shows the cutting off finished and the forming lever L about to return the cut-off rest to the mid-position. Fig. 8 shows the cut-off rest back in the mid-position.

The disk cams have been dealt with at some length so that their action might be thoroughly understood. When laying these out it is only necessary to draw the forming lever L and the cut off lever M in the mid-position, and at the "finish forming" and the "finish cutting off" positions; then to draw the cams on a piece of tracing paper on the top, which can be moved round for the different positions of the levers, in a similar manner that the positions of the disk and levers are shown in Figs. 5, 6, 7, and 8.

These cams can now be referred to the turret slide cam drum in the following manner. From the "start forming" to the "finish forming" the cut-off disk moves through $18\frac{1}{2}°$; then the equivalent distance on the drum is $\frac{65.97'' \times 18.5°}{360°} = 3.39$ inches, which can be laid off on the drum from the "start forming" line. Again, the number of degrees moved through by the disk from the "start forming" to the start cut-off is 59°; the equivalent distance on the drum is $\frac{65.97'' \times 59°}{360°} = 10.8$ inches. This can be laid off on the drum from the "start forming" line, other positions being obtained in a similar manner.

Having laid down all the cams, it is necessary to see that the cutting-off tool is well clear of the job before the chuck commences to open. Possibly it will be found that it is not, in which case the cams on the turret slide cam drum and cut-off disk should be looked through to see if any space on the drum can be saved. If this is insufficient, a different size of feed pulley C should be used.

No hard and fast rules can be laid down as to what angles should be used, as these will vary for different machines owing to the difference in details, and hence each machine must be considered independently.

* * *

MACHINE TOOLS AND MACHINE SHOP PRACTICE DURING THE TEN YEARS FROM 1890 TO 1900.

Regarding the development of machine tools and machine shop practice during the ten years that elapsed between 1890 and 1900, Mr. Edward H. Sanborn says, in Bulletin No. 247 on Metal-working Machinery, that progress has been marked by the following significant features:

1. The automatic and semi-automatic principles have been extended to new and larger classes of work than before.
2. The forming tool has become a recognized shop appliance.
3. The "oil-tube drill" has been developed from an exceptional to a regularly used tool.
4. Compressed air portable tools have been developed substantially from the beginning.
5. The application of the power press has been greatly extended.
6. Electrical driving has come into general use.
7. The system of heavy portable machine tools in conjunction with a massive iron floor plate has been originated.
8. The grinding machine has been largely increased in size, power, and extent of use.

Closely related to machine shop practice, though scarcely coming within mechine-tool classification, may be mentioned:

9. The development of traveling cranes.
10. The origin of high-speed steels for cutting tools.

These lines of development may be discussed briefly in the above order.

1. The extension of the semi-automatic principle, as illustrated by the hand-operated turret lathe, has been chiefly toward the execution of larger and heavier work, while the use of the entirely automatic turret lathe has been not only in the same direction, but has been adapted to entirely new classes of work. An illustration of the first line of development is found in several types of turret lathes which, although employing certain methods of attacking the work which were not known before their advent, is nevertheless essentially an extension of the turret principle to larger work than had before been done by it.

An illustration of the second line of development is to be found in the "magazine feed" full automatic turret lathe. Prior to the advent of this machine, the full automatic machine had been employed exclusively for making screws, studs, etc., from bar stock which was fed to the machine

through the hollow live spindle, the pieces being first turned, threaded, etc., and then cut off, when the bar of stock was fed downward and another piece made, the operation continuing until the bar of stock was used up. The new machine applied the automatic principle to the machining of parts which, when in the rough, were already in separate pieces, i.e., castings or drop forgings. In doing such work the finished piece must be taken bodily from the machine and a new rough piece inserted. This is a fundamentally different operation from merely pushing a long bar of stock to a new position. It is effected by the "magazine feed," the magazine being filled with rough parts by the workman, these parts then being automatically inserted in the machine and removed therefrom when finished. The line of development exemplified by the machine first mentioned belongs to the entire decade, while that exemplified by the other belongs to its close.

Another line of development in this class of machines which should be mentioned is the use of multiple spindles, whereby the output of certain classes of work is very greatly increased—to the extent of a threefold ratio in some instances. An outgrowth of this development has been the making of small brass screws and similar articles without money consideration, the chips cut off in making the articles being accepted as sufficient payment for doing the work.

2. The use of the forming tool goes back of the decade under consideration, but its use prior to 1890 was chiefly, if not entirely, for the making of articles from very soft composition castings, examples of the work being seen in the caps of salt and pepper boxes. The application of the principle to harder material came about in connection with the bicycle industry, one of its final applications to articles of steel being in the making of bicycle-wheel hubs. If this is not the first application of the method to steel, at least it familiarized the mechanical public with it, and from this it has come to have quite an extended application.

3. By the "oil-tube drill" is meant a drill—either flat or twist—having an oil tube or oil channel leading to or near its point, through which a current of oil may be forced to lubricate and cool the cutting edges and to wash away the chips. It is used chiefly for deep drilling in steel and usually in machines of the lathe class, in which the work revolves against a fixed drill, although the arrangement is also used in upright drilling machines, in which the tool revolves. The history of this appliance is almost exactly parallel to that of the forming tool. It was known and used to a limited extent before 1890, having first been used for the drilling of gun barrels; but its more extensive application must, like that of the forming tool, be credited to the bicycle industry, the development of the two tools being, in fact, simultaneous. The forming tool having been successfully applied to the machining of the outside of bicycle-wheel hubs, it was found that a portion of the gain due to its faster action was lost because the simultaneous drilling of the hole required more time than the work upon the outside of the piece. This condition of things led to the adoption of the oil-tube drill for this work, and from this application the use of the appliances has become widely extended. Of the two, the oil-tube drill is no doubt the more important. The increasing use of hollow-spindle lathes and automatic and hand-operated turret lathes, in which the spindles are necessarily hollow, not to mention milling and other machines having hollow spindles, has given a wide field of usefulness to this tool.

4. The numerous class of small and unpretentious pneumatic tools which came into prominence and extended use during the decade under review may, it is quite possible, be looked upon as the most important single machine tool development of the decade. Of these, the first in order of importance as well as of time is the pneumatic hammer. Originally devised as a substitute for the hand hammer and chisel in the machine shop and in stone-cutting, it has extended its field of usefulness to many other fields, and is to-day an indispensable tool in shipbuilding and in the erection of steel-frame buildings. Of the general class of compressed air tools, the next in importance to the hammer is perhaps the rotary drill, which, in its numerous forms and applications has introduced mechanical power in place of hand labor for classes of work to which the application of mechanical power seemed almost hopeless. These and numerous other applications of compressed air to machine and similar work stand almost wholly to the credit of the decade 1890 to 1900, the hammer alone having been in use prior to 1890.

5. The great expansion in the use of power presses which has taken place during this decade must be credited largely to the growth of the electrical industries. The advent of the laminated armature for electric generators and motors called for accurately-made punchings of sheet metal of a size and in numbers previously unknown. The power press furnished the natural method of making them, and in its development the capabilities of the machines were demonstrated as they had never been before.

6. The electric motor as a means of driving machine tools was first seriously proposed about or shortly before the middle of the decade, and was generally looked upon by mechanical men as a fad of the electrician. The innovation nevertheless obtained a foothold, and advantages which were not foreseen were found to attend it. It has become the accepted method of driving factories (*a*) which are composed of many departments, the flexibility and economy of the system in distributing power over a considerable area from a central station being here the factor of dominating importance, and (*b*) those which are of a nature requiring tools and machines to be located at considerable distances apart, especially if they are also to be intermittently operated. It is also making rapid progress in machine shops, to which the above limitations do not apply, though in such applications opinion regarding its merit is still unsettled. A leading controversial point is the attachment of individual motors to each machine tool *versus* group-driving of several machines through a single motor and a line shaft. There are well-defined conditions under which each method is suitable, but there is still a wide intervening field of debatable ground. As a matter of fact, in this field the individual motor is making rapid progress—more so perhaps than can be readily explained.

7. Like the increased development of power presses, the floor plate portable tool system of attacking heavy work must be credited to the electrical industries, which in this instance, curiously enough, furnished both the work for which the system was first devised and the means for doing the work. It was to the machining of the ring or magnet frames of large electric generators that the system was first applied, and the electric motor supplied the only practicable method of driving the tools which form part of the system. The system has not yet found much application outside of electrical work, although a beginning has been made, and this growth will doubtless continue.

8. The grinding machine was first devised during the past decade as a means of doing superior work, but it was not long before it became evident that it was a source of economy as well as a means of securing superior workmanship. The full significance of this was, however, slow to be realized, and it was not until toward the close of the decade that the movement began toward a very marked increase in capacity, weight, and power of the machine.

9. In no feature of machine shop practice has there been greater progress in American shops during this decade than in the provision of crane facilities. Twenty years ago the absence of these facilities was a national reproach, but to-day there is undoubtedly better crane service in the United States than exists elsewhere. This development is to be credited to the electric motor, without which it is at least doubtful if the present stage of progress could ever have been reached. The mere transmission of the power required for cranes of present capacities by the old square shaft or flying rope would be a serious problem. Electricity furnishes, in fact, an ideal method of driving cranes, and the necessary installation of an electric plant for operating cranes has no doubt greatly furthered the adoption of electric power for other purposes.

10. Within the last few years discoveries have been made whereby certain classes of tool steel are made to endure cutting speeds which before were impossible. Like all other

useful things these steels have certain limitations and it is too early to state definitely what their ultimate economic importance will be. It is reasonably certain, however, to be considerable.

* * *

STANDARD EQUIPMENTS FOR MOTOR-DRIVEN PLANERS.

The G. A. Gray Co., manufacturers of planers, Cincinnati, O., have devoted a great deal of attention to the arrangement of motor drives for their machines, and have so systematized the methods for motor attachment as to have certain standard forms of brackets and connections between motor and planer adapted to all requirements. They are prepared to furnish three different types of standard drives for their spur-geared planers and two types for their spiral-geared planers.

A motor drive is made up of two parts, the electrical, or motor equipment, and the mechanical, or supplementary equipment, which latter includes the countershaft, pulleys, etc., with brackets cast on the housings, and shelf fitted to same, for supporting the apparatus. These latter are so designed as to be adapted to any type of motor that may be applied to the planer, so that it will not be necessary to prepare special drawings or patterns to meet the needs of different customers. Thus, if a customer orders a planer and states that he wishes to use a motor of certain make and which runs at certain speed, the particular style of drive adapted to the specifications is selected and the brackets are cast on the housings from the regular patterns in stock.

The three types of motor drive adopted for the spur-geared planers are as follows:

The silent chain-geared drive, Fig. 1 on the opposite page;
The direct-connected drive, Fig. 2;
The motor-belted drive, Fig. 3.

The two types of drive for the spiral-geared planers are:

The self-contained drive, illustrated in Fig. 4;
The motor-belted drive, illustrated in Fig. 5.

It will be noticed that the silent chain-geared drive, Fig. 1, is entirely self-contained, and permits the use of a medium or high speed motor, instead of the more expensive slow speed motor required for the direct-connected drive shown in Fig. 2. The countershaft is mounted on a shelf, bolted to brackets cast on the housings, and is driven by means of a Renold silent chain, from a motor mounted close to it on the same shelf.

With such necessarily short center distances, a belt might not work satisfactorily, and spur gearing might gradually wear noisy, on account of the difficulty of maintaining the permanency of alignment necessary to smooth and quiet running.

The silent chain may be run slack and cannot slip like a belt. It does not require fixed centers, as is essential with gearing. It is, therefore, peculiarly adapted to this type of drive.

The direct-connected drive, Fig. 2, is also entirely self-contained. The motor is mounted on a shelf, bolted to brackets cast on the housings, and the driving pulleys are placed on the motor shaft; thus making it possible to belt directly down to the planer.

This type of drive makes it necessary that the motor run at countershaft speed; and the motor-shaft must be extended to carry the driving pulleys, and the pulley which operates the power-elevating device. In order to relieve the motor bearing from the undue strain, an independent outside bearing is furnished.

The motor-belted drive, as shown in Fig. 3, permits the use of a medium or high-speed motor, the pulleys being so proportioned that the countershaft will be run at regular speed. This countershaft is mounted on a shelf, bolted to brackets cast on the housings, and is driven by belt from a motor placed on the floor, or in a more convenient location.

In the self-contained drive, as applied to *Spiral*-geared planers, and shown in Fig. 4, the countershaft is mounted on a shelf, bolted to brackets cast on the housings, and is driven by belt, from a motor mounted on same shelf.

This type of drive permits the use of a medium or high-speed motor, the pulleys being so proportioned that the countershaft will be run at regular speed; and the center distances are such that a belt drive is perfectly practicable; the motor being provided with means for taking up the slack of belt.

In the motor-belted drive for spiral-geared planers, Fig. 5, the countershaft is mounted on a shelf, which is bolted to a bracket cast on the front housing, and which is furthermore supported by an outboard column resting on the floor. The countershaft is driven by a motor placed on the floor alongside of the planer, or in a more convenient location. This type of drive also permits the use of a medium or high speed motor.

When a complete motor equipment is furnished by the planer manufacturers, the outfit includes a multipolar iron-clad motor, a universal motor-starting rheostat with automatic release; overload and current indicator; main switch and covered fuse connections. The rheostat, indicator and switch are mounted on a slate slab, and wired complete. It is therefore only necessary to fasten the slab in position and connect the binding posts with the line wires and motor, in accordance with the diagram sent with each outfit. If a customer prefers, however, he may supply the motor equipment himself and the builders will then furnish only the supplementary equipment, which would include the brackets, shelf, etc., as mentioned above.

Where a customer orders a planer complete with regular countershaft, but intends at some future time to apply electric drive, the housings can be prepared by casting on the brackets, ready to receive the Standard motor-shelf. The motor power required for driving a planer obviously depends upon such a variety of conditions that the company generally recommend such powers as they consider ample for average service. It should be remembered, however, that the amount of power necessary at the moment of reversal, and for the "quick return," is vastly in excess of what is required to merely drive a planer while cutting, and for that reason it is advisable to provide a larger motor than the actual work would require.

* * *

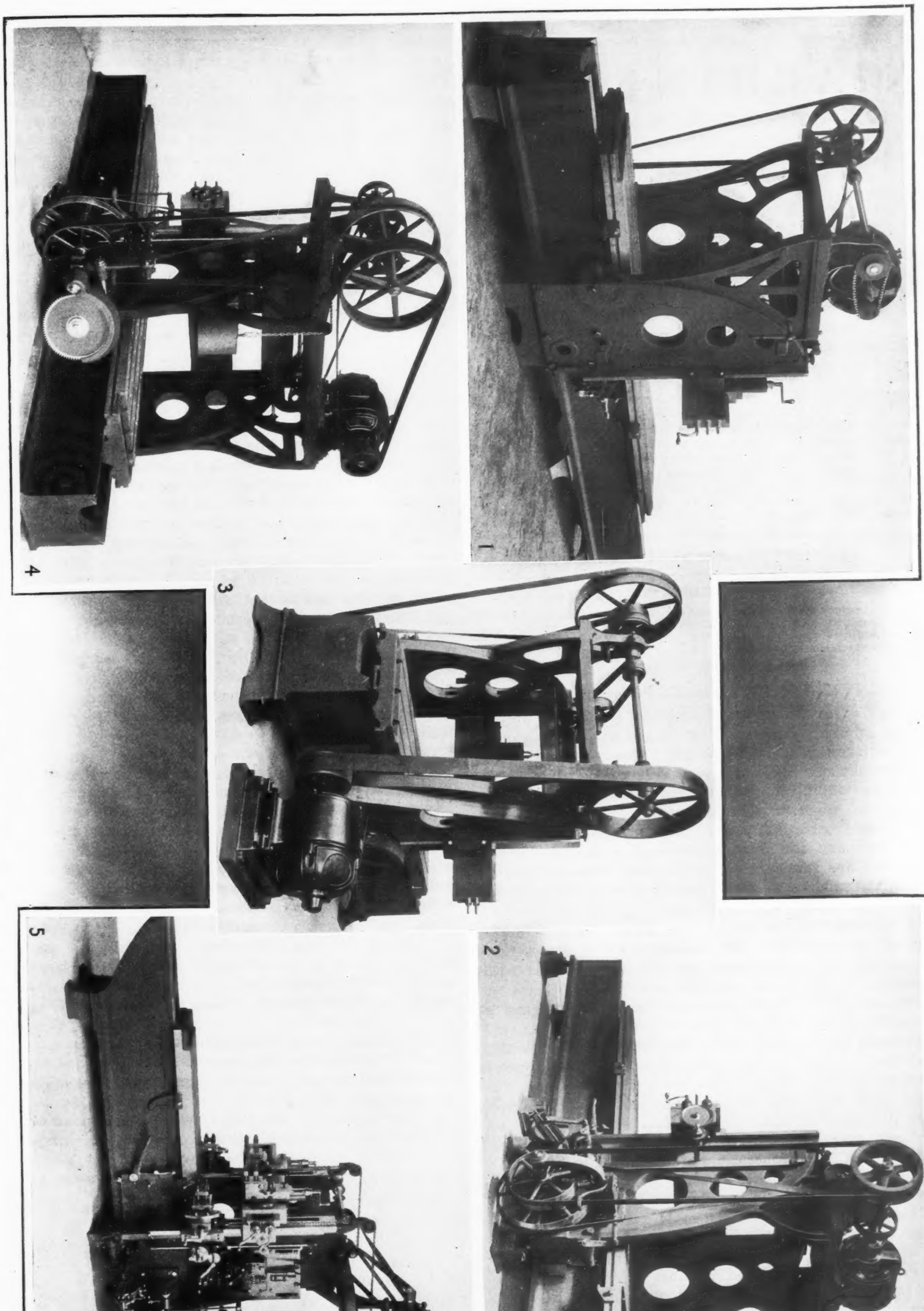
MAKING SCREWS WITHOUT WASTE OF MATERIAL.

The latest development of automatic screw machinery about which we have been informed, is a machine that makes machine screws from a coil of wire without entailing any waste of the material. That is to say, the product from a coil of wire, weighing 50 pounds, would be 50 pounds of screws. This surprising result is obtained, of course, by the avoidance of all tool cutting action except that necessary to separate the screw from the stock, the screw being formed, head and all, entirely by swaging and rolling. This machine which is being perfected by a Springfield, Mass., inventor, first straightens the wire from the coil, then the end is caught between swaging dies of peculiar construction and given a rapid series of blows which form the body of the blank and partially form the head. The body of the blank which is to be threaded, is swaged to a smaller diameter to allow for the increase of diameter due to rolling the thread. After the first swaging operation, the blank is cut from the wire and thrust into a die where the head is fully formed, and the slot for the screwdriver punched at the same time. This punching action removes no stock, but expands the head so that it fills the die. After this has been done the blank is picked up and carried between two hardened threading rollers which roll the thread and complete the making of the screw.

Just what future there is in store for such a machine, we would not care to predict, but it appears that there is always a field open for any machine that effects a saving in time, material or attendance. When all three features are combined in one machine, its advantages seem obvious. The first machines for making wire nails, wasted a small portion of the wire between each nail in cutting the points. This waste, we believe, has been eliminated in the later machines and the economy resulting is of considerable importance, making almost the difference between profit and loss at times in the past.

* * *

It is stated that the largest steel plate ever rolled was one recently turned out by the Parkgate Works, England; it is 30 feet long, 10 feet 6 inches wide and seven-eighths of an inch thick.



Standard Motor Drives for Planers adopted by the G. A. Gray Co., Cincinnati, O.

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ENVIRONMENT IS RESPONSIBLE.

The reasons for the success of American competition abroad and the avowed "supremacy" of the American workman have been investigated by the so-called Mosely commission of English workmen. The commission was composed of secretaries of 23 leading trade unions, who made an extended trip through this country, visiting important plants like the Schenectady Locomotive Works, the works of the General Electric Company, the Niagara power plant, the steel works of Cleveland and Pittsburg, the Cramp and Baldwin works of Philadelphia and many establishments in other fields of industry.

In a recent number of the *Outlook* certain features of the report of the commission are touched upon by Mr. George Lynch, a London correspondent intimately acquainted with the work of the visitors. He mentions—what we have already contended in these columns—that the mechanic is very much the same man on either side of the Atlantic, and that it is his environment, rather than his nationality, which stimulates or retards his progress. In America he is more productive because his influences are such as to make the product of his labor much greater than when under the more conservative and less favorable conditions which exist abroad.

To begin with, American climate is invigorating and conducive to work. The American workman lives in better surroundings, and works under better and more healthful conditions in the factory. He is influenced by the natural tendency to push work at its most rapid rate, devising where possible, mechanical ways to do this. The delegates repeatedly remarked that American mechanics do not seem to work harder than those in England, but they accomplish more because they make their minds save their hands. They make the machine take the wear and tear, if they can.

In this country, where so many factories are of recent construction, it is not surprising that they should be filled with new machinery; but the delegates were apparently surprised to find the scrap pile heaps so large in the vicinity of the older works, indicating that the American is disposed to throw out any machine almost as soon as it has been improved upon. Not the least important phase of the subject, however, is the fact that the workman in America indulges less in alcoholic beverages than the English workman, statistics showing that the consumption of these is more than twice as great per capita in Great Britain as in the United States.

Incidental to the trip should be mentioned the expressions of surprise on the part of the Englishmen that the manufacturers of America should have so universally kept "open house" for them. It was well known that no body of American workmen, skilled in the various arts and who would be quick to pick up ideas, could investigate the ways and methods of English shops, with anything like as great a degree of freedom. In other words, the country which is acknowledged supreme in its trade accomplishments has fewer secrets to hide than its less aggressive rival. May it not be that the same rule holds in respect to individual firms? We not only believe it does, but know that it does in many instances.

* * *

AN APT PHRASE FOR THE MECHANIC.

The veteran Senator Hoar of Massachusetts, in his recent speech upon the trust problem, drew a very pretty picture of Worcester, Mass., as a mechanic's home and alluded briefly to the many inventors who had at one time or another lived near that city. Eli Whitney, who doubled the value of every acre of land on which cotton grew, was born near Worcester; so was Bigelow, the inventor of the carpet loom; and so, also, was Blanchard, the inventor of the lathe for turning irregular forms. Elias Howe, the inventor of the sewing machine, was born and lived near Worcester, and the card clothing machine and the envelope machine were also invented or developed in that city. In referring to the results that have come from the work of such mechanics, the Senator very aptly said that "it was not water power or steam power or electricity that wrought this miracle; it was brain power."

This is a good phrase to remember and to live by. While plenty of men get along without brain power, they are generally men who are held up by props of some kind or other, and if the props were knocked out they would fall with them. Even the great trust, of which the Senator spoke, with all its wealth and untold resources cannot get along without brain power, which it will always have to pay for.

Especially would we commend the phrase to the young mechanic. Do you wish to succeed in the world? It is very easy to enumerate the things that *will not* contribute to that end. No mechanic will advance because he does not do his work intelligently; nor because he does not study; nor because he does not cultivate the power of observation or the habit of reading the technical papers, which tell him what others are doing in his own field of work. In short, no man ever succeeded because he did not use his brain. Not all mechanics can rise to the distinction of Eli Whitney or Elias Howe, or perhaps to any distinction at all. But it is morally certain that great mechanics like these would never have been heard of if they had not used their brains. Whatever may be the industrial conditions of the country through the great movements of modern times, let it be remembered that brains are the one staple commodity that the world cannot do without. The moral is to cultivate and develop the brain as well as the muscle and the future will take care of itself.

* * *

EFFECT OF GAS ON COAL TRANSPORTATION.

One of the great changes possible in future industrial development may be the establishment of great gas-making plants in the near vicinity of coal mines, and the conveying of the gas to cities by immense pipe line systems. This would largely do away with the present wasteful and expensive method of getting fuel to market by hauling coal in railway cars. A modern steel coal car weighs forty per cent. as much as the coal it can carry, and the car has to be hauled both ways. This, with weight of the locomotive, makes it practically about the same as hauling a ton of dead weight one way for each ton of freight. The proportion of dead weight hauled is usually much greater, especially when older equipment is used. The principal expense attending the movement of gas in mains is entailed by the pressure necessary to force it through, which would have to be developed by pumps. In

the past, however, the cost of making gas has been a bar to its competing with coal in the manner outlined, so the only places where gas is generally used for fuel are those where natural gas is cheaply supplied. The price of natural gas varies in different localities, being from ten to fifteen cents per 1,000 cubic feet in some western Pennsylvania towns. In the future the conditions will be different, if a gas-making process developed by a Pittsburg mechanical engineer is as successful as reported. By this process it is claimed that fuel gas can be made at a cost of $.0108 (1.08 cents) per 1,000 cubic feet. A ton of coal produces by the new process 25,000 cubic feet of gas having a heat efficiency of 560 B. T. U. per cubic foot at a cost of $1.43. The by-products are 600 pounds of coke, 10 gallons of tar and sufficient ammonia liquor per ton to reduce the cost to the extremely low figure quoted. Even if there was no market for the by-products the cost of the manufactured gas would still be extremely low.

* * *

ELECTRIC RAILROADING.

In the last number of the *Technology Quarterly* is an article by Prof. Louis Duncan upon long-distance electric railroading that gives an interesting survey of electric traction as the problem now presents itself. Prof. Duncan is an engineer of wide experience, and has recently been appointed professor of electrical engineering at the Massachusetts Institute of Technology. He does not see the doom of the locomotive as plainly as perhaps some of the more enthusiastic members of the profession, for he believes there are several important factors that will tend to retard the progress of electric traction between distant points, especially with the through-train service of the leading roads. He contends that for through service a single car or even two cars are not enough to give the comfort to which the traveler is accustomed. This requires heavy trains of a number of cars, and even for a certain class of suburban traffic where a large amount of traveling is concentrated at certain hours, heavy trains must be used, requiring a great deal of power for each train.

In the transportation of freight, also, the tendency is toward heavy trains, because the minimum cost is attained with the maximum weight of train. The average train load on the Pennsylvania Railroad has increased about 75 per cent. in twenty years, and the capacity of the cars is over 100 per cent. Under these conditions he contends that continuous-current motors, receiving current either directly from a central station or from substations, are not applicable. The possibilities of congestion of traffic, especially in freight transportation, would make it necessary to have the capacity of substations enormous as compared with the average power required on the line, which would involve an immense increase in the original investment and some increase in the operative expenses.

Another difficulty is in the large amount of switching to be done, much of it of a complicated nature. If electricity is to be used in terminals and freight yards, a locomotive must be designed which is economical at all speeds, and which is under perfect control, and current must be supplied to these locomotives by some means which will not endanger the lives of the train hands. Railroading is dangerous enough as it is, and any additional source of danger must be avoided.

While the position of Prof. Duncan is very well taken, supposing that future railroading operations on electrically-equipped lines were to be conducted as they now are on steam railroads, it seems that this would be a mistake and directly against the tendencies of electrical operation (as manifested in passenger traffic, at least) which are, to run short trains and many of them. By doing this the public is better served and earnings increased without at the same time disproportionately increasing the operating expenses. The same should hold true to a large extent with freight traffic. Because we are used to having freight cars take a week or more in going from New York to Chicago, it is no sign that this is the proper condition of affairs or that it is one that will always exist in railroad operation. Long heavy trains necessarily mean slow movement of freight with possibly a minimum expense for wages of the trainmen; short trains mean quick freights and a slight increase per ton mile in wages, it is true, but the gross and net earnings would undoubtedly be greatly increased. The road bed of a railroad earns interest and dividends only while trains are passing over it and cars earn only in proportion to their mileage. If a freight car makes the round trip from New York to Chicago in a week, it earns just double what it does when making the trip one way in a week, and fewer cars are required for the same volume of freight. Without going into further argument in the matter it seems to us that the future of railroading lies more in the direction of shorter trains at high speeds, both for passenger and freight service, than in following the present trend with steam locomotives as the motive power.

* * *

NOTES AND COMMENT.

In his diary for 1843, Samuel F. B. Morse wrote: "The inference is that telegraphic communication on my plan may with certainty be established across the Atlantic. Startling as this may seem now, the time will come when this project will be realized." Yet this was only sixty years ago and men who were then old enough to have laughed at such a suggestion have lived to witness wireless communication across the ocean.

The *Philadelphia Record*, in a department devoted to scientific and mechanical notes, reproduces a cut of the motor-driven grinders manufactured by the Ransom Mfg. Co., Oshkosh, Wis., which have the motor armature directly on the grinder spindle, with the following description: "The familiar old grindstone is growing out of date and its place is being taken by the piece of machinery shown above. The stone wheels are driven by an electric motor encased in the base of the machine." Comment is unnecessary.

Some small work is not thought much of, and the doers of it are apt to receive scant consideration. Never despise, however, the maker of the small paragraph in a dire emergency to fill the corner of a page. Some of the quickest work of the editor is often done in those corners, and no wonder it does not always match what precedes it.—*American Machinist.*

There are notes and notes. The foregoing filled "the corner of a page" and was probably written in "dire emergency." A certain religious paper, so we are informed, has a stock of short prayers on hand, ranging from half-a-dozen to a score or so of lines in length, ready to be set in type for any and all occasions when a note is required to fill a certain space. But it is seldom that a technical editor has to practice sacrilege to fill his columns. There are usually enough pertinent facts at hand to supply the material for pithy notes, and it is frequently a matter of surprise to find that the notes published in MACHINERY bring numerous inquiries to this office, sometimes, in fact, more than the longer articles. This would indicate that some of the "small work" of the editor receives its fair share of attention, and we trust that the prayers of the religious editor may be answered as frequently.

As an illustration of what can be done with the new tool steels now appearing on the market, Prof. J. J. Flather, in an address before the Association for the Advancement of Science, stated that he had recently seen some steel locomotive driving wheels which had been turned in two hours and forty minutes, whereas the regular time previously had been not less than eight hours, with the old steel. Even better results might have been obtained, but the belts would not carry the load. Prof. Flather also related an anecdote to show how the tendency to increase the number of compressed air devices in machine shop work has sometimes led to extremes, and that in many cases the work could have been done just as cheaply by hand. The case in point was an apparatus that at one time was in use on one of our prominent Western roads. It was a sort of portable crane hoist which could be fastened to the smokestack of a locomotive, whereby one man could lift off the steam chest casing. The hoisting apparatus weighed about twice as much as the steam chest and took three men to put it up. When piece work was adopted two men easily lifted off the steam chest and this "labor-saving device" was relegated to the scrap heap.

A NEW INTERNAL COMBUSTION ENGINE.

LARGE HORIZONTAL GAS ENGINES DESIGNED BY THE WESTINGHOUSE MACHINE CO.

Much interest has of late been aroused by the exhibition abroad of numerous makes of high-power engines of the internal combustion type, and subsequent reports concerning their probable manufacture in America. Although much more attention has been devoted to this type of prime mover abroad, and its development has therefore been more marked, it is noteworthy that American manufacturers have in the meantime been conducting operations along this line with the result that internal combustion engines of American design and American manufacture, in sizes as high as several thousand horse power, are in evidence for service as exacting and severe as that for which the high-grade steam engine is now almost universally employed.

In the domestic field, few makers have ventured above 250 horse power, and none above 500 horse power, until recently, with one exception—the Westinghouse Machine Company, whose three-cylinder vertical single-acting engine is well known. The company have, however, been for some time engaged in developing the double acting engine, and are now prepared to build this type for powers ranging as high as 3,000 horse power. As this type of engine possesses features somewhat novel to those accustomed to the usual reciprocating engine design, a brief description may be of interest.

Fig. 3 is from a photograph of a single-crank engine of the new type, and Figs 1, 2 and 4 the general design of a 1,500 horse power double-crank engine, direct connected to a D. C. or A. C. generator.

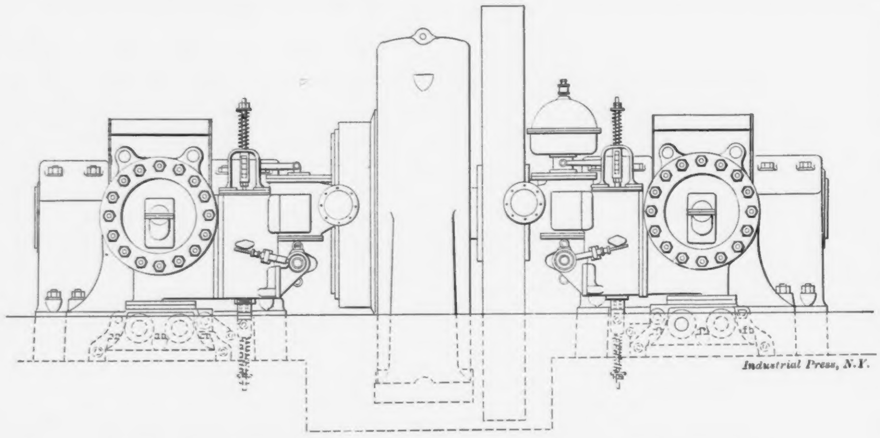

Fig. 1. End View of 1500 H. P. Double-crank Gas Engine, Direct Connected.

The general design of the engine somewhat resembles that of the modern high-speed tandem compound steam engines in the arrangement of cylinders, frames, bed-plate, bearings, flywheel and generator. This resemblance is further carried out in the matter of crank effort. The engine operates on the four-stroke cycle, and as there are two double-acting cylinders an impulse is given at each stroke of the engine as in the steam engine.

The employment of the four-stroke cycle involves the important feature of positive scavenging which is here accomplished by the piston during its exhaust stroke, thus avoiding all weakening of the incoming mixture by the inert gases from the previous explosion, and insuring uniform operation. In all engines employing the two-stroke cycle, scavenging must be accomplished either by a special piston movement or by a blast of air from an auxiliary pump directed in such a manner as to force out the remaining burned gases, thus clearing the way, so to speak, for the incoming pure mixture. This latter method is the most practical, but has the inherent disadvantage of the incoming gas mixing with more or less of the air used in scavenging, causing a variation in the calorific value of the explosive mixture, which, for a gas of given constituency, should remain constant for the best results.

The Westinghouse design employs a mixture of unvarying quality, which is initially proportioned according to the nature of the gas used, but which remains constant under all conditions of load. As the loads upon the engine increase or decrease, a corresponding greater or lesser quantity of mixture is admitted to the cylinders, thus utilizing at all times an explosive mixture of maximum strength, resulting in

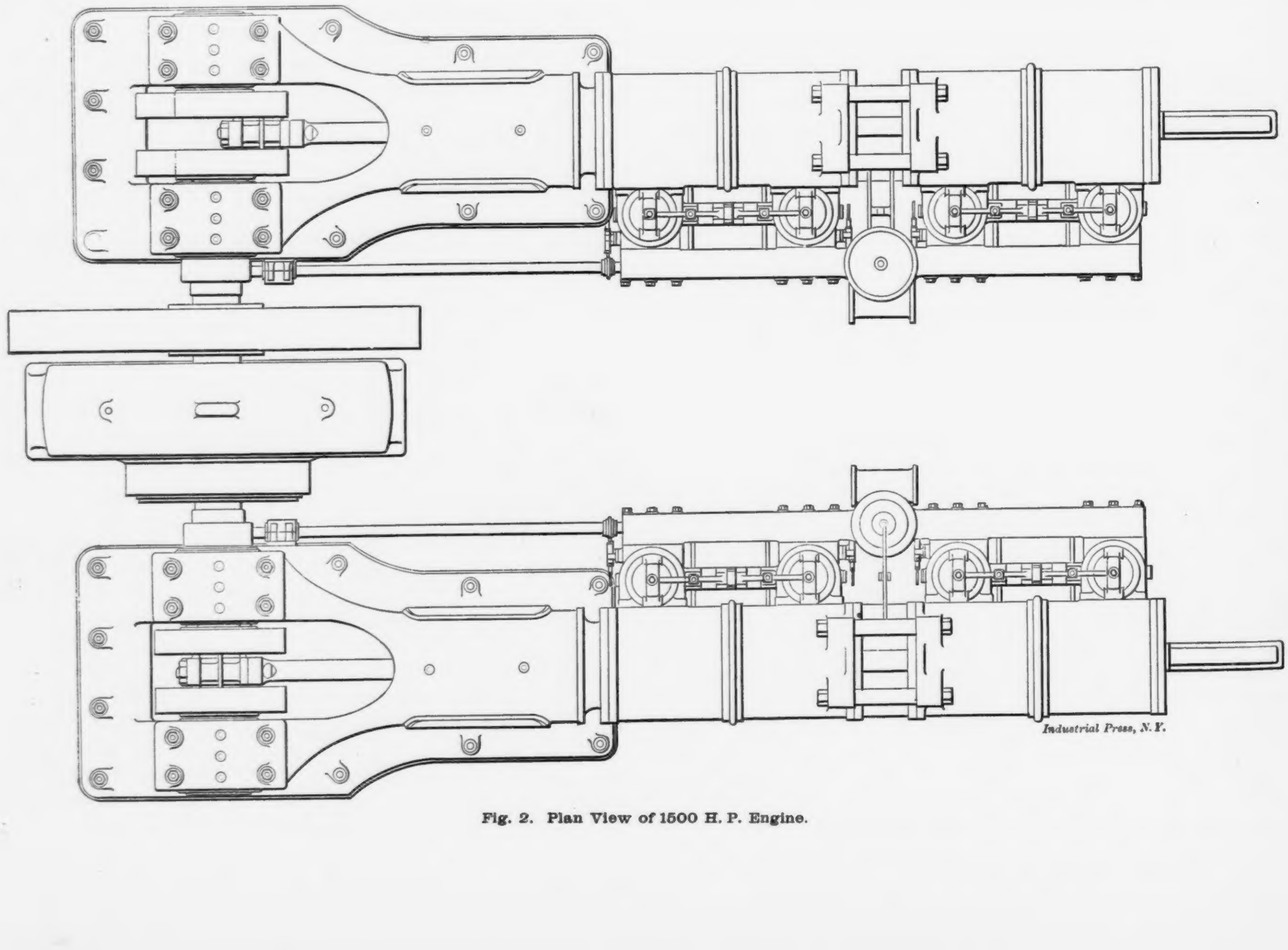

Fig. 2. Plan View of 1500 H. P. Engine.

Supplement to MACHINERY, February, 1903.
Data Sheet No. 17.

MACHINERY'S 6 x 9

PUNCH PUNCH

CREASE HERE.

CIRCUMFERENCES AND DIAMETERS OF CIRCLES.

Circum.	Diameter.	Circum.	Diameter.	Circum.	Diameter.	Circum.	Diameter.
1	.3183	26	8.2761	51	16.2338	76	24.1916
2	.6366	27	8.5944	52	16.5521	77	24.5099
3	.9549	28	8.9127	53	16.8704	78	24.8282
4	1.2732	29	9.2310	54	17.1887	79	25.1465
5	1.5915	30	9.5493	55	17.5070	80	25.4648
6	1.9099	31	9.8676	56	17.8254	81	25.7831
7	2.2282	32	10.1859	57	18.1437	82	26.1014
8	2.5465	33	10.5042	58	18.4620	83	26.4197
9	2.8648	34	10.8225	59	18.7803	84	26.7380
10	3.1831	35	11.1408	60	19.0986	85	27.0563
11	3.5014	36	11.4592	61	19.4169	86	27.3747
12	3.8197	37	11.7775	62	19.7352	87	27.6930
13	4.1380	38	12.0958	63	20.0535	88	28.0113
14	4.4563	39	12.4141	64	20.3718	89	28.3296
15	4.7746	40	12.7324	65	20.6901	90	28.6479
16	5.0930	41	13.0507	66	21.0085	91	28.9662
17	5.4113	42	13.3690	67	21.3268	92	29.2845
18	5.7296	43	13.6873	68	21.6451	93	29.6028
19	6.0479	44	14.0056	69	21.9634	94	29.9211
20	6.3662	45	14.3239	70	22.2817	95	30.2394
21	6.6845	46	14.6423	71	22.6000	96	30.5577
22	7.0028	47	14.9606	72	22.9183	97	30.8761
23	7.3211	48	15.2789	73	23.2366	98	31.1944
24	7.6394	49	15.5972	74	23.5549	99	31.5127
25	7.9577	50	15.9155	75	23.8732	100	31.8310

Computed by W. I. MANN, Pittsburg, Pa.

PUNCH PUNCH

CREASE HERE.

CIRCUMFERENCES AND DIAMETERS OF CIRCLES (Continued).

Circum.	Diameter.	Circum.	Diameter.	Circum.	Diameter.	Circum.	Diameter.
201	63.9803	226	71.9380	251	79.8958	276	87.8535
202	64.2986	227	72.2563	252	80.2141	277	88.1718
203	64.6169	228	72.5747	253	80.5324	278	88.4901
204	64.9352	229	72.8930	254	80.8507	279	88.8085
205	65.2535	230	73.2113	255	81.1690	280	89.1268
206	65.5718	231	73.5296	256	81.4873	281	89.4451
207	65.8901	232	73.8479	257	81.8056	282	89.7634
208	66.2085	233	74.1662	258	82.1240	283	90.0817
209	66.5268	234	74.4845	259	82.4423	284	90.4000
210	66.8451	235	74.8028	260	82.7606	285	90.7183
211	67.1634	236	75.1211	261	83.0789	286	91.0366
212	67.4817	237	75.4394	262	83.3972	287	91.3549
213	67.8000	238	75.7578	263	83.7155	288	91.6732
214	68.1183	239	76.0761	264	84.0338	289	91.9916
215	68.4366	240	76.3944	265	84.3521	290	92.3099
216	68.7549	241	76.7127	266	84.6704	291	92.6282
217	69.0732	242	77.0310	267	84.9887	292	92.9465
218	69.3916	243	77.3493	268	85.3070	293	93.2648
219	69.7099	244	77.6676	269	85.6254	294	93.5831
220	70.0282	245	77.9859	270	85.9437	295	93.9014
221	70.3465	246	78.3042	271	86.2620	296	94.2197
222	70.6648	247	78.6225	272	86.5803	297	94.5380
223	70.9831	248	78.9409	273	86.8986	298	94.8563
224	71.3014	249	79.2592	274	87.2169	299	95.1747
225	71.6197	250	79.5775	275	87.5352	300	95.4930

Computed by W. I. MANN, Pittsburg, Pa.

x 9 DATA SHEETS.

These data sheets are intended to be cut into four sections, 6 x 9 inches in size, as indicated by the straight lines. They may then be bound into note book form for convenient reference by means of staples inserted in holes punched at the points indicated.

224	71.3014	249	79.2592	274	87.2169	299	95.1747
225	71.6197	250	79.5775	275	87.5352	300	95.4930

25	7.9577	50	15.9155	75	23.8732	100	31.8310

PUNCH

PUNCH

CREASE HERE.

PUNCH

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CREASE HERE.

CIRCUMFERENCES AND DIAMETERS OF CIRCLES (Continued).

Circum.	Diameter.	Circum.	Diameter.	Circum.	Diameter.	Circum.	Diameter.
101	32.1493	126	40.1070	151	48.0648	176	56.0225
102	32.4676	127	40.4254	152	48.3831	177	56.3408
103	32.7859	128	40.7437	153	48.7014	178	56.6592
104	33.1042	129	41.0620	154	49.0197	179	56.9775
105	33.4225	130	41.3803	155	49.3380	180	57.2958
106	33.7408	131	41.6986	156	49.6563	181	57.6141
107	34.0592	132	42.0169	157	49.9747	182	57.9324
108	34.3775	133	42.3352	158	50.2930	183	58.2507
109	34.6958	134	42.6535	159	50.6113	184	58.5690
110	35.0141	135	42.9718	160	50.9296	185	58.8873
111	35.3324	136	43.2901	161	51.2479	186	59.2056
112	35.6507	137	43.6085	162	51.5662	187	59.5239
113	35.9690	138	43.9268	163	51.8845	188	59.8423
114	36.2873	139	44.2451	164	52.2028	189	60.1606
115	36.6056	140	44.5634	165	52.5211	190	60.4789
116	36.9239	141	44.8817	166	52.8394	191	60.7972
117	37.2423	142	45.2000	167	53.1578	192	61.1155
118	37.5606	143	45.5183	168	53.4761	193	61.4338
119	37.8789	144	45.8366	169	53.7944	194	61.7521
120	38.1972	145	46.1549	170	54.1127	195	62.0704
121	38.5155	146	46.4732	171	54.4310	196	62.3887
122	38.8338	147	46.7916	172	54.7493	197	62.7070
123	39.1521	148	47.1099	173	55.0676	198	63.0254
124	39.4704	149	47.4282	174	55.3859	199	63.3437
125	39.7887	150	47.7465	175	55.7042	200	63.6620

Computed by W. I. MANN, Pittsburg, Pa.

Lengths of Chords for Spacing Circle whose Diameter is 1.—For Circles of other Diameters Multiply Length Given in Table by Diameter of Circle.

No. of Spaces.	Length of Chord.	No. of Spaces.	Length of Chord.	No. of Spaces.	Length of Chord.	No. of Spaces.	Length of Chord.
		26	.1205	51	.0616	76	.0413
		27	.1161	52	.0604	77	.0408
3	.8660	28	.1120	53	.0592	78	.0403
4	.7071	29	.1081	54	.0581	79	.0398
5	.5878	30	.1045	55	.0571	80	.0393
6	.5000	31	.1012	56	.0561	81	.0388
7	.4339	32	.0980	57	.0551	82	.0383
8	.3827	33	.0951	58	.0541	83	.0378
9	.3420	34	.0923	59	.0532	84	.0374
10	.3090	35	.0896	60	.0523	85	.0370
11	.2817	36	.0872	61	.0515	86	.0365
12	.2588	37	.0848	62	.0507	87	.0361
13	.2393	38	.0826	63	.0499	88	.0357
14	.2225	39	.0805	64	.0491	89	.0353
15	.2079	40	.0785	65	.0483	90	.0349
16	.1951	41	.0765	66	.0476	91	.0345
17	.1838	42	.0747	67	.0469	92	.0341
18	.1736	43	.0730	68	.0462	93	.0338
19	.1646	44	.0713	69	.0455	94	.0334
20	.1564	45	.0698	70	.0449	95	.0331
21	.1490	46	.0682	71	.0442	96	.0327
22	.1423	47	.0668	72	.0436	97	.0324
23	.1362	48	.0654	73	.0430	98	.0321
24	.1305	49	.0641	74	.0424	99	.0317
25	.1253	50	.0628	75	.0419	100	.0314

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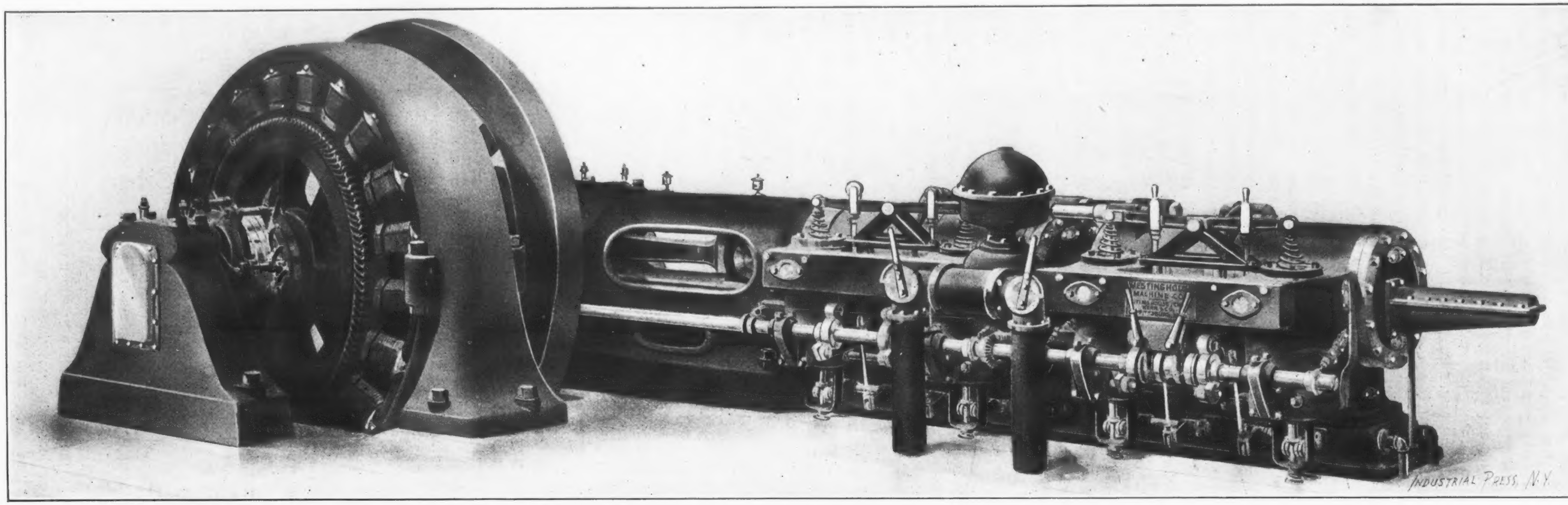


Fig. 3. General View of 750 H. P. Double-acting Single Gas Engine. (Photograph copyrighted.)

high thermal efficiency and economy of fuel. That this method is productive of the best results in engines of high power is apparent from the fact that reputable European builders, such as the Deutz Cockerill and Nurberg companies are abandoning the variable for the constant mixture method of governing.

The construction of the engine under description departs materially from the accepted European design and embodies many features of modern steam engine practice. The design of cylinders, pistons and valves, of course, departs materially from steam engine practice. The cylinders are double walled, with the outer walls split peripherally to permit independent expansion and contraction without placing the cylinder casting under stress. The two cylinders are united at the top by heavy tie-rods, engaging peripheral bosses, and at the bottom by a stout cast-iron distance piece. The rear section of the bed-plate which supports the two cylinders is cored hollow with a central dividing wall, and serves as a reservoir for incoming and outgoing circulating water. All connections are piped directly to these reservoirs, thus avoiding a large amount of piping about the engine. Through the bed-plate extend the four vertical exhaust pipes, which connect immediately below with an exhaust main. The exhaust passages leading from the valve chambers are cast integral with the cylinders, upon their sides, and are water cooled.

At the ends of each cylinder occur horizontal side ports, resembling straight steam ports, which communicate with removable combustion chambers, bolted to vertical bosses.

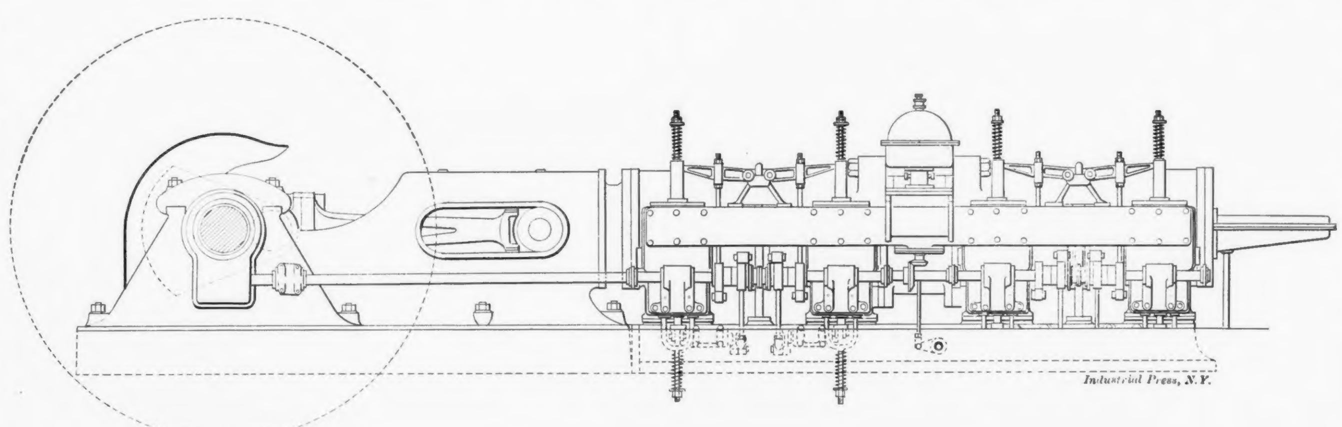


Fig. 4. Side View of 1500 H. P. Engine.

The cylinders are closed by water-jacketed heads, split diametrically for facility in inspection of the interior, and the two halves are united with a ground fit, no packing being found necessary. This feature obviates the necessity for completely dismantling the engine for inspection.

The arrangement of valves and combustion chambers in the new design is simple and in marked contrast to the complexity of numerous European types. The latter still make use of the cylinder head or "breech end casting" for the location of combustion chambers, admission

and exhaust valves, mixing and igniting chambers, and supports for the cam shafts, rocking levers, etc. This concentration of so many important functions in a single casting, which at best is already complex, is questionable. The arrangement shown in the accompanying illustrations accomplishes the same purpose at less cost and with less complexity. The combustion chambers are independent castings, with plain machined faces, circular valve liner seats, and cored out passages for circulating water. Both admission and exhaust valves, which are of the standard poppet type, operate vertically and with opposite throw. They seat under pressure, open by cam movement and close by spring pressure. The central space, closed by the admission valve above, and the exhaust below, communicates directly with the cylinder port before mentioned; the exhaust space with the exhaust passages on the under sides of the cylinder; the admission space with the supply pipe. This supply pipe is a rectangular cast-iron main extending along the entire front and provided with openings opposite each admission valve. It receives its supply from the governor chamber located midway between the two ends, this in turn communicating with a mixing chamber supplied on the one hand with gas, and on the other with air, through suitable valves. These two valves are shown in Fig. 4, and are provided with graduated indices, so that the exact proportions of gas and air may at all times be visible and under the control of the attendant. Each valve, together with its spindle and seating spring, is independently mounted, and by simply removing the bolts from the bonnet, the entire valve, seat and liner may be drawn out for inspection or replacement by another. Similarly, the igniters, which are of the "make and break" electrical contact type, are mounted in a removable plug extending into the combustion chamber through the side walls. The valve gear is of the cam and roller pattern, and is driven by a helical gear, engaging a similar split gear bolted around the main shaft. The entire gear may be instantly disengaged by a special trip coupling inserted on the driving rod.

The method of circulating cooling water is unique. This water enters a cavity in the crosshead by means of a flexible tube connection with the reservoir in the bedplate. It then flows through the hollow piston rod to the forward piston, around which it circulates thence through the second rod to the rear piston; thence through a brass tail rod extending through the rear head and there empties into a cast-iron jacket bolted to the rear head and communicates with the hot water outlet pipe. Similarly cold water is conducted through suitable pipes to the cylinder jackets, thence to the jackets surrounding the exhaust valves and ports, and finally to the return pipe, emerging at a sufficiently high temperature for use in heating and drying coils, radiators, etc.

The engine pistons are constructed in two parts, with packing rings and babbitted bearing surfaces. They are secured in position on the rods by internal nuts and present plain convex surfaces to the burning gases. Piston rods are of forged steel, with bored water ducts. Between the two cylinders close fitting brass sleeves are used for packing, and split ring bushings in the outer cylinder head.

The engine is started by compressed air pumped into a steel reservoir during a previous run before shutting down. For this purpose a special disengaging gear is provided which isolates the rear cylinder. In starting, this air is admitted to the rear cylinder by the regular valve mechanism temporarily connected to the compressed air system and the explosion cycle in the forward cylinder is immediately started. The rear cylinder may then be thrown into action. Oiling is accomplished by steam engine appliances, such as sight feed cups, cylinder pumps, and oil rings for crank pins.

The engine is governed by a sensitive fly-ball governor of the standard design, protected by a circular housing. It operates a vertical piston valve supplying a fuel mixture of constant quality, but in quantities proportionate to the load.

The single crank engine is at present manufactured in sizes ranging from 150 to 750 horse power, and the double crank from 750 to 1,500 horse power. In the latter, the cranks are placed at 90 degree angularity, giving four impulses per revolution, and crank effort corresponding to that of the cross-compound double-acting steam engine.

It is of interest to note that several installations of this type of engine are in progress. The first will be at the works of the Consolidated Industries Company, Batavia, N. Y., which will employ 250 horse power single-crank double acting engines. A special coke and gas process, known as the Lowe, will be employed, yielding three products—metallurgical coke and coal and water gas, the former to be retailed and the two latter combined and used for power purposes. The second installation will be put into operation at the works of the Atlantic Refining Company, Philadelphia. The engines are double-crank, double acting, of 500 horse power each, and will operate upon a rich oil gas of approximately 1,200 British thermal units per cubic foot—a by-product of the refining process. Both these installations will be direct-connected to Westinghouse generators.

A third interesting installation at Hillburn, N. Y., will supply the entire Ramapo Valley with light and power from a new station now building for the Rockland Electric Company. This plant will also operate upon producer gas, using the Loomis-Pettibone process. The producer plant is located in a separate building and supplies water gas to the Ramapo Iron Works and the Ramapo Foundry Company for heating and metallurgical purposes, as well as power gas to the generating station. The electrical distribution system will supply power to local industries, as well as lighting for the Ramapo Valley, some fourteen miles in extent. The equipment aggregates 1,200 horse power, employing 350 horse power single-crank engines of the double-acting type, and a small vertical single acting engine for driving the exciter. Each main engine is direct connected to Westinghouse polyphase generators, arranged for parallel operation. This plant will be one of the first alternating current stations in the country to be operated from gas power.

A further and more recent instance of the confidence placed in gas power apparatus is that of the Potosina Electric Company, of San Luis Potosi, Mexico, a town of 70,000 inhabitants, situated at an elevation of about 6,000 feet above sea level, about 275 miles northwest of Mexico City. The town was formerly supplied with electric light and power from a D. C. steam-driven plant which passed into the control of the present company and has been converted to a gas power alternating current central station arranged for parallel alternation upon a single distributing system.

The plant has been laid out for five main units, an exciter unit, and a compressor, aggregating 1,225 horse power, and will also employ the Loomis-Pettibone process for generating a power gas of approximately 120 British thermal units per cubic foot, calorific value.

The four installations above noted are among the first applications of fuel gas to power purposes, and the advent of the modern high power gas engine should serve to open up an entirely new field in gas engineering. A number of power gas processes are now available, including the Loomis-Pettibone, Taylor, Mond, Otto Hoffman, Lowe, Dellwick, Fleischer and Dawson and the results obtained from installations now in service give every reason to believe that the gas-power station will shortly be much in evidence. At present three main and two auxiliary units will be installed, the remaining two units, each of 340 horse power, being added as required.

* * *

Modern Machinery reports that a peculiar affection has appeared in the glass windows of York Cathedral, England. The glass has become dull and fragile and filled with holes. Windows that have been in place for six or seven hundred years have lately been removed in order to arrest this curious form of deterioration. The trouble, which may properly be named a "disease," is ascribed to a fungus, but in what way it attacks glass is not yet definitely known. Possibly it dissolves the silica in order to form a shell such as those of the microscopic diatoms that make up the fine siliceous deposits found in Germany and other countries. Glass is not the only hard substance that may succumb to such attacks, for a species of bacteria is known to disintegrate the hardest cements, and has thus wrought havoc in water reservoirs.

BOILER HORSE POWER FOR HEATING AND POWER.

CHAS. L. HUBBARD.

The standard for one "boiler horse power" is the evaporation of 30 pounds of water from a temperature of 100 degrees into steam at 70 pounds gage pressure. This is equivalent to the evaporation of 34.5 pounds from a temperature of 212 degrees into steam at atmospheric pressure, and requires 34.5×966=33,327 heat units, which for all practical purposes we may take as 30,000.

It has been found by experience that in plain tubular boilers, one square foot of heating surface will evaporate about 2.3 pounds of water "from and at 212 degrees," which corresponds to 15 square feet of heating surface per H. P. (34.5÷2.3=15). In well proportioned boilers, with careful firing, this can be somewhat reduced and some engineers give as low a figure as 11.5 square feet per H. P. All computations and tables given in this article will be based on 15 square feet per H. P., which experience has found to be safe and to result in durable construction. In computing the heating surface of tubular boilers it is customary to take one-half the area of the shell, two-thirds the rear head less the tube area, and the interior surface of all the tubes.

The H. P. required for heating a building may be computed in different ways, according to the data at hand. It may be based on the radiating surface to be placed in the building, or upon the heat loss through walls and windows. If ventilation is to be provided for a part or the whole of the building special allowance must be made for this also. Let us first take up the case where the amount and kind of radiation to be supplied by the boiler is known. One square foot of direct radiation, provided with low pressure steam (2 to 5 pounds), will give off from 200 to 300 heat units per hour. We may take for the average cast-iron radiator of medium height and thickness, an efficiency of 250 heat units; for a pipe coil, 300; for indirect pin radiators or other cast-iron indirect radiators of similar form, 600; although indirect radiation is not so efficient in heating the room itself, and for steam blast, 1,500. From this we have:

$$\frac{30,000}{250} = 120 \text{ sq. ft. direct radiator per H. P.}$$

$$\frac{30,000}{300} = 100 \text{ sq. ft. direct pipe coil per H. P.}$$

$$\frac{30,000}{600} = 50 \text{ sq. ft. indirect radiator per H. P.}$$

$$\frac{30,000}{1,500} = 20 \text{ sq. ft. steam blast per H. P.}$$

When the radiating surface of a building is not known we must either first compute it by one of the various methods in use or calculate the horse power directly from the heat loss through the walls and windows of the building.

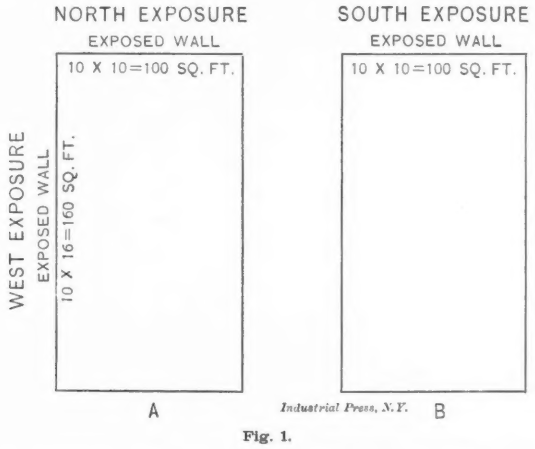


Fig. 1.

It is common practice among steamfitters and others to base the radiating surface required for any given room upon its cubic contents. While this is a convenient way of making approximations or of checking up results obtained in other ways, it is not accurate enough for computing the sizes of radiators for separate rooms unless the results are corrected for different conditions by a person of experience. This is made evident by an illustration. Take the case of two rooms having the same cubic contents and located as shown in Fig 1. *A* has an outside wall exposure of 100+160=260 square feet toward the north and west, while *B* has only 100 square feet of exposure toward the south. While a person of any experience would make a difference in the size of radiators of the two rooms, I have seen important pieces of work in which the radiating surfaces had been computed from the cubic contents of the room, regardless of the wall exposure.

When we come to deal with whole buildings instead of separate rooms the method becomes more rational and may be used with a fair degree of accuracy.

The following table has been made up from the averages of several different rules in common use, and gives the cubic feet of space that may be warmed by 1 square foot of different kinds of radiation for various types of buildings. From this table we may easily calculate another which will give the horse power per 1,000 cubic feet of space for the different types of buildings named above.

TABLE I.

KIND OF BUILDING.	Direct Cast Iron Radiators.	Direct Pipe Coils.	Indirect Cast Iron Radiators.
Dwellings	50	60	35
Stores, Wholesale	125	150	90
" Retail	100	120	70
Banks and Offices	70	85	50
Dry Goods Stores	80	95	60
Large Hotels	100	120	70
Churches	150	180	105

TABLE II.

TYPE OF BUILDING.	Boiler H. P required for each 1000 Cubic Feet of Space for Direct Radiation.	Boiler H. P. required for each 1000 Cubic Feet of Space for Indirect Radiation.
Dwellings	.167	.286
Stores, Wholesale	.066	.111
" Retail	.083	.143
Banks and Offices	.119	.200
Dry Goods Stores	.104	.166
Large Hotels	.083	.143
Churches	.055	.066

For example.—Take the case of a large hotel to be heated with direct cast-iron radiators. From the above table we find that 1 square foot of radiation will heat 100 cubic feet of space; or 1,000÷100=10 square feet will be required to heat 1,000 cubic feet of space. We have already found that 1 boiler H. P. will supply 120 square feet of direct cast-iron radiators. Therefore 10÷120=.083 H. P. is required for each 1,000 cubic feet of space to be warmed. In the same manner this may be found for different types of buildings for both direct and indirect radiators. We will now take up a more accurate method, in which the exposed wall and window surfaces, the construction and location of the building are taken into consideration, as well as the cubic contents. The heat loss from a building takes place in two ways: First by conduction through the walls and windows, and second by leakage around doors and windows and even through the walls themselves.

TABLE III.

MATERIAL.	Heat Units Loss per Square Foot per Hour with Outside Temp. at 0	Heat Units Loss per Square Foot per Hour with Outside Temp. at 20° below 0
12″ Brick Wall	17	22
16″ " "	14	18
20″ " "	13	16
24″ " "	11	14
28″ " "	10	13
Wooden Construction	14	18
Single Windows	70	90

The average loss by conduction in heat units per square foot of exposed surface per hour for different kinds of walls

and for windows are given in Table III, P. 305. Column 2 gives values when the outside temperature is at 0 and column 3 when it is 20 degrees below zero. It is assumed in each case that the inside temperature is to be maintained at 70 degrees. The actual heat loss is obtained by multiplying the square feet of exposed wall and window surface by the corresponding factor for the case in hand.

To the heat loss found by the above table must be added that due to leakage. It is customary to consider this equal to one change of the entire contents of the building every hour under ordinary conditions. The amount of heat lost in this way may be computed as follows: One heat unit will raise the temperature of 1 cubic foot of air 55 degrees at average temperatures and pressures, or it will raise 55 cubic feet 1 degree. Therefore the heat units required to raise any given quantity of air through any number of degrees in temperature may be found by multiplying the cubic feet of air by the number of degrees it is to be raised, and divide the result by 55. If the entire amount of air in a building is lost by leakage every hour, it must be replaced by unheated air from out-of-doors; and the heat lost by leakage will be that required to raise the incoming air to the inside temperature of the building. In zero weather this will be

$$\frac{\text{Cubic contents of building} \times 70}{55}$$

This is simplified by computing the loss for 1 cubic foot of space and multiplying the cubic contents of the building by the factor thus found.

For zero weather we have,

$$\frac{1 \times 70}{55} = 1.3$$

and for 20 below zero,

$$\frac{1 \times 90}{55} = 1.64$$

For example.—What horse power of boilers will be required in zero weather to heat a building 40×80 feet, having 3 stories, each 10 feet high? The walls are of brick 16 inches in thickness and the window area equals one-fifth the total exposed wall area.

Total exposed wall and window area $= (40+40+80+80) \times (3 \times 10) = 7{,}200$.

Window area $= 7{,}200 \div 5 = 1{,}440$.

Net wall area $= 7{,}200 - 1{,}440 = 5{,}760$.

Cubic contents of building $= 40 \times 80 \times 30 = 96{,}000$.

The heat loss per hour will be,

$$
\begin{aligned}
1{,}440 \times 70 &= 100{,}800 \\
5{,}760 \times 14 &= 80{,}640 \\
96{,}000 \times 1.3 &= 124{,}800 \\
\hline
& \quad 306{,}240 \text{ heat units.}
\end{aligned}
$$

and

$$\frac{306{,}240}{30{,}000} = 10.2 \text{ H. P.}$$

This should be increased 10 per cent for the leakage through roof if there is an attic space, giving,

$10.2 \times 1.1 = 11.2$ H. P.

If there is no attic space, the roof should be counted the same as wooden construction, which in the above case would give $(40 \times 80) \times 14 = 44{,}800$, and the total heat loss would be, $306{,}240 + 44{,}800 = 351{,}040$, which divided by 30,000 gives 11.7 H. P. This is based on the assumption that the building is sheltered by other buildings. If it stands by itself in an exposed location, the boiler power should be increased about 20 per cent. over that given in the above case,

$11.7 \times 1.2 = 14$ H. P.

Small heating boilers have been found to be less efficient than those of larger size, depending partly upon their construction, but more especially upon the unskilled firemen usually employed in caring for them. The following factors, computed from data given by Prof. Carpenter in "Heating and Ventilation of Buildings," may be used for increasing the power of the smaller sizes, when calculated by the rules already given:

Boilers of 5 H. P., multiply by 1.4.
Boilers of 10 H. P., multiply by 1.23.
Boilers of 15 H. P., multiply by 1.14.
Boilers of 20 H. P., multiply by 1.07.

In the foregoing discussion the usual average conditions of chimney draft, fuel and care have been assumed. These vary so widely in different cases that no *exact* rule can be given to cover all conditions. The actual power of boilers depends so largely upon the draft, care of heating surface, and management of fires, that they may be made to develop under favorable circumstances a capacity at least 30 per cent. above their ratings. This, however, is not usually taken into account when computing the required size of a boiler for any special purpose, but is held as a reserve power for emergencies. Cast-iron sectional boilers are used almost exclusively for warming dwelling houses, and also used to a considerable extent in churches, halls, etc. When a boiler of this type is required its power is usually based upon the grate surface and the probable rate of combustion. The ratio of heating to grate surface varies from 15 to 25 in the best makes. For these we may assume a combustion of 5 pounds of coal per square foot of grate and an efficiency of 60 per cent., which corresponds to about 8,000 heat units per pound of coal available for useful work.

In computing the size of boiler for any given case it is only necessary to find, by some of the methods given, the total number of heat units to be supplied per hour, and divide this by $(8{,}000 \times 5)$ which will give the required grate area in square feet. The most efficient rate of combustion will depend somewhat upon the ratio between the grate and heating surfaces. It has been found by experiment that about ¼ pound of coal per hour for each square foot of heating surface seems to give the best results, so by ascertaining the ratio of heating surface to grate surface for any given make of boiler, we may easily compute the most efficient rate of combustion and from it determine the necessary grate area.

For example.—The heat loss from a building is 480,000 heat units per hour? We wish to use a heater in which the ratio of heating surface to grate area is 24. What will be the most efficient rate of combustion and the required grate area? $480{,}000 \div 8{,}000 = 60$ pounds of coal to be burned per hour; and $24 \div 4 = 6$, which is the best rate of combustion to employ.

TABLE IV.—NON-CONDENSING.

Boiler Pressure.	Ratio of Expansion.					
	2	3	4	5	7	10
	Pounds of Steam per Hour.					
30	40	39	40	40	42	45
45	35	34	36	36	38	40
60	30	28	27	26	30	32
75	28	27	26	25	27	29
90	26	25	24	23	25	27
105	25	24	23	22	22	21
135	24	23	22	21	20	20

TABLE V.—CONDENSING.

Boiler Pressure.	Ratio of Expansion.					
	2	3	4	5	7	10
	Pounds of Steam per Hour.					
15	30	28	28	30	35	40
30	28	27	27	26	28	32
45	27	26	25	24	25	27
60	26	25	25	23	22	24
75	26	24	24	22	21	20
105	25	23	23	22	21	20
135	25	23	22	21	20	19

Therefore $60 \div 6 = 10$, the grate surface required.

If ventilation is to be provided in a building the boiler power for this must be computed and added to that already found for heating. This is computed in the same manner as that to cover the heat loss by leakage, and the formula is:

Cubic feet of air supplied per hour × degrees through which it is to be raised ÷ by 55 = heat units required, and this ÷ by 30,000 = boiler H. P. necessary to supply this heat.

Calculations for power boilers are based on the steam consumption of the type of engine to be used. Table IV above, from Prof. Thurston's "Manual of Steam Engine" gives

the average quantity of steam required per H. P. per hour by different types of engines working under different rates of expansion. This applies to the best class of engines in common use when of moderate size and in good order. Small engines, having greater proportional losses in friction, leaks, radiation, etc., and receiving, generally, less care in construction and running than larger ones, require more steam per H. P. In such cases the figures in the tables should be increased at least 50 per cent.

Having ascertained from the tables the weight of steam required per hour for any given engine, and knowing the probable temperature of the feed water and boiler pressure to be carried, the weight of steam can be reduced to an equivalent evaporation "from and at 212 degrees;" and this result divided by 34.5 will give the boiler H. P. required. This should be increased somewhat for running feed pumps, etc., or for any other purpose for which steam is used.

* * *

THE NEW YORK AUTOMOBILE SHOW OF 1903.

As we go to press the annual automobile show is in progress at Madison Square Garden, and the number of exhibits is much larger than in previous years. The marked development in the character and quality of the products during the past year is very evident. The average product of the different builders is greatly improved in every respect, and what is most noticeable is the almost universal adoption of the French type of carriage, having the motor in a suitable casing in front of the chauffeur, the body and seats of the carriage being of the tonneau type. Even the manufacturers of steam cars are adopting this design, such concerns as the White Sewing Machine Co., makers of the White steam carriage, laying particular stress upon designs which resemble the French gasoline automobile, so far as outward appearance is concerned. Manufacturers of light runabouts are also shaping their vehicles after this style, and in the whole show there were but few carriages having the "horseless" look of the typical American carriage of a year or two ago, which retained the dashboard but not the thills.

The gasoline motor carriages were greatly in the majority, there being 63 makes of these exhibited, while only 13 makers of steam vehicles and eight of electric vehicles had exhibits. The touring car was in evidence everywhere, seating usually four people and costing in the neighborhood of $2,500.

As yet there is apparently no practical low-priced automobile on the market, the cheapest exhibited costing $550. There is a tendency to use air cooling for gasoline cylinders, either by arranging plans for creating a current of air, or by other means, thus avoiding the use of water entirely, making the motor adapted to the coldest weather. There was also nothing particularly new to be seen in the way of heavy motor trucks for commercial use, this part of the show being lamentably weak. It is apparent from this that one of the greatest uses of the automobile of the future—that of transporting heavy loads in our crowded city streets—is not receiving the attention it deserves. Apparently the sporting element in automobilism far outweighs the commercial element, so far as the use of it is concerned.

One of the most unpretentious exhibits—and to the writer the most interesting—was a complete set of cells of the new Edison storage battery. The set comprised 38 cells, weighing 600 pounds, and capable of driving a light runabout 100 miles. It is estimated that a lead battery weighing 100 pounds less, (or 500 pounds) would drive an automobile only 40 miles. The Edison battery is a work of art as regards construction, and shows that a great deal of study and experimental work has been done to develop it. To say that its construction is neat enough to create admiration on the part of any one versed in mechanical matters, is not an exaggeration. The plates in this battery are composed alternately of carbon and nickel, and of iron; one serving as negative and the other as positive pole. In charging the battery a deposit is formed on the half plate and this again is re-formed on the other half when the battery discharges, and there is absolutely no deterioration in the plates, so far as can be determined. The writer was shown one plate that had done use in a battery of a carriage which had traveled over 3,000 miles, and it showed no effect of its use. It was also said to weigh exactly the same as at the start. Another advantage claimed for the battery is that it can be charged rapidly, taking a few minutes only, without danger of injuring the battery, instead of requiring four or five hours, as with the lead battery.

The Edison storage battery will be on the market this spring, but the representative at the exhibit would give no estimates as to its probable selling price. If the battery will accomplish the results claimed for it, and it is placed on the market at a reasonable figure, the electrical automobile will certainly receive a great impetus and become the favorite vehicle with a large number of people.

* * *

EFFECT OF VIBRATION ON STEEL TUBING.

C. H. BENJAMIN.

It has frequently been claimed by the makers and by the users of bicycles that the steel tubing of the frames is unfavorably affected by vibration due to constant and long-continued use. The writer has heard bicycle men assert that frames taken from old machines are often brittle and easily broken on this account. This is evidently but another form of that persistent delusion concerning the so-called crystallization of iron and steel during use. Perhaps some may consider it a waste of powder to fire at ghosts, but if the ghosts can be thereby permanently laid, the expenditure will be justified.

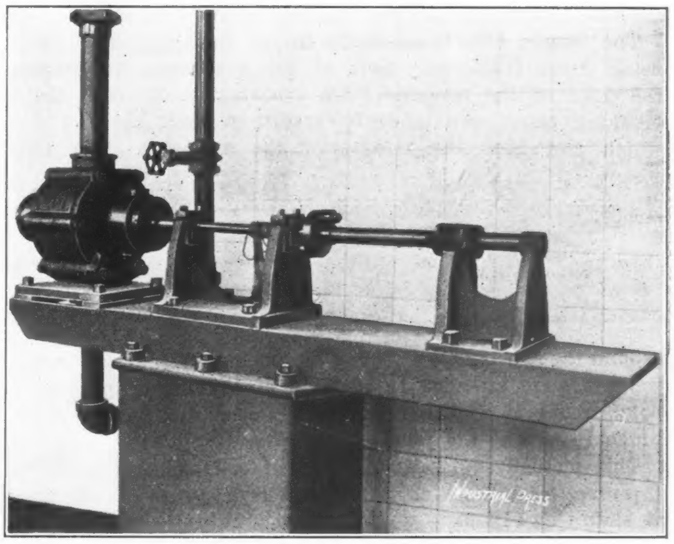


Fig. 1. Testing Apparatus Driven by Dow Turbine.

During the winter of 1898-99 a series of experiments on bicycle tubing was made under the direction of the writer. These tests were conducted at the laboratories of the Case School by Messrs. Austin and Brown, senior students. They merely served to confirm the opinions of good authorities on this subject, but the details may be of sufficient interest to warrant publication.

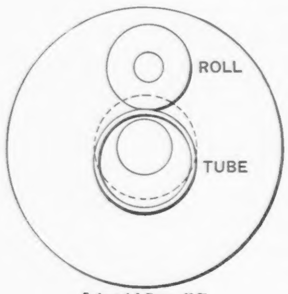
The cut, Fig. 1, shows the general arrangement of the apparatus, which resembles in construction a speed lathe. The tube to be experimented upon is clamped firmly in the tailstock of the machine and projects a greater or less distance to furnish a free length for vibration.

On the free end of the tube is a hardened steel sleeve, to protect it from injury. The revolving spindle carried by the headstock of the apparatus has a crank disk and pin fastened to its end and revolving with it. A hard bronze roll on the crankpin bears directly on the cylindrical sleeve beforementioned, rolling around it as the spindle turns. The axes of the revolving spindle and of the tube coincide but the surface of the roll is a distance from the axis less than the radius of the hardened sleeve. As the roll travels around the sleeve it accordingly springs the tube away from the center in every direction, giving to it what may be called a progressive vibration in all planes. Fig. 2 illustrates this springing of the tube.

The amplitude of the vibrations is easily changed by vary-

ing the size of roll. Several experiments showed the best results from a free length of nine inches and an amplitude of 5-64 inch. An attempt to use longer tubes resulted in the tube leaving the roll altogether on account of the centrifugal force at the high speed used. The deflection of $\frac{2.5}{64}$ in this length corresponded to a lateral pressure of 30 or 40 pounds, and a fiber stress of about 14,000 pounds—the stresses, of course, rapidly alternating between tension and compression.

The machine was driven by a Dow steam turbine, as may be seen in Fig. 1. The speed used was about 5,000 revolutions per minute and a run of between three and four hours was sufficient to give a million complete vibrations to the tube.



Industrial Press, N.Y.

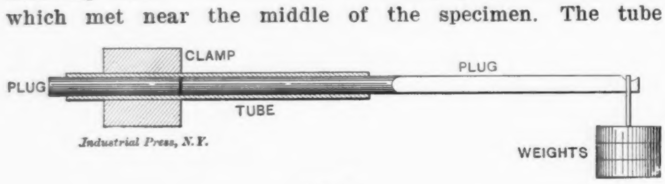
Fig. 2.

A four-break commutator was attached to the spindle and this put in circuit with a battery and a telephone receiver.

By comparing the musical tone produced in the receiver with a pitch pipe and tuning fork the speed could be readily determined.

Pieces cut from the same tube, one of which had been subjected to vibration and one not, were tried in the testing machine and the tensile strength and modulus of rupture determined.

The tensile tests were made in the usual manner, plugs being fitted inside the ends of the specimens, to prevent the jaws of the machine from crushing them. The cross-breaking tests were made by inserting plugs at each end which met near the middle of the specimen. The tube



Industrial Press, N.Y.

Fig. 3.

around the shorter plug being clamped in a cylindrical holder, weights were attached to the end of the longer plug at a point about 30 inches from the clamp—until the specimen broke in two at the joint.

This method avoids any danger of collapsing or crushing the tube and gives a clean break at right angles to the axis, as shown in Fig. 3.

TABLE I.

No.	Kind of Tube.	Number of Vibrations.	Bending Moment, lbs. inches.	Fiber Stress due to Deflection.	Ultimate Load in Tension.
2	Pope, .50 Carbon	500,000	....	......	9,160
3	Pope, .50 Carbon	None	....	......	9,140
5	Brazed Tube	1,000,000	342	14,700	8,080
6	" "	None	....	......	8,630
11	Pope, .50 Carbon	1,000,000	....	......	10,530
12	Pope, .50 Carbon	None	....	......	10,640
20	Shelby	1,000,000	324	14,000	6,800
21	"	None	....	......	6,890
30	Pope, Nickel	1,000,000	288	12,300	7,200
31	" "	None	....	......	7,450

Three different makes of tubes were tested but no attempt was made to compare the three kinds, the object being solely to determine the effect of vibration. Table 1 shows the results of the tension experiments and Table II. those of the cross-breaking.

Tubes Nos. 5 and 6 in Table I. had been heated and dipped into a brazing bath, as bicycle joints are sometimes treated.

A comparison of the figures for the two tubes in each pair, as bracketed in the first column, showns no material differences between the vibrated and un-vibrated specimen, as regards either tensile or cross-breaking strength. In other words, one million repetitions of a tensile stress of 12,000 or 14,000 pounds, alternating with compressive stresses of the same amount, have no perceptible effect on the strength or character of steel tubing. The appearance of the metal at fracture was the same, no sign of molecular change being apparent.

TABLE II.

No.	Kind of Tube.	Number of Vibrations.	Breaking Load at 29½ inches.	Modulus of Rupture.
1	Pope, .50 Carbon	1,000,000	90	114,000
4	Pope, .50 Carbon	None	95	120,500
10	Pope, .50 Carbon	1,000,000	101	128,000
13	Pope, .50 Carbon	None	101	128,000

Some of the characteristics of the different varieties are, however, well brought out. Nos. 2, 3, 11 and 12 were of the same kind and make, but the last two were cut from a different tube and were about 15 per cent. stronger. Nos. 5 and 6 were from the same tube as 2 and 3 but having been heated in a brazing bath were weakened thereby.

The chemical constitution of Nos. 20 and 21 was not known. The nickel steel, Nos. 30 and 31, was not so stiff as the other, and the same deflection caused less pressure and bending moment. This steel also shows less tensile strength than the .50 per cent. carbon.

* * *

THE DATA SHEET FOR THIS MONTH.

The tables presented on the data sheet accompanying this month's issue of MACHINERY were contributed by Mr. W. I. Mann, Pittsburg, Pa. They comprise a list of circumferences and diameters from 1 to 300 and a table of the lengths of chords for spacing a circle whose diameter is unity. The table of circumferences and diameters is deserving of particular notice in that it is arranged in the reverse order from that usually found in tables of this kind. The tables which are found in all of the standard hand-books give the diameters in whole numbers, halves, quarters and sometimes eighths and the corresponding circumferences in decimals to three or five places, as the case may be. This table reverses this arrangement and gives the circumferences in whole numbers and the diameters in decimals to four places.

It often happens that the most convenient way to make a measurement is circumferentially and to obtain the diameter the result is divided by 3.1416 or, what is more convenient, multiplied by .3183. The result would, of course, be found directly from this table. Another application of the table is found in laying out gearing to circular pitch. The circumferences, in this case, are usually in whole numbers, being the product of an even pitch by the number of teeth. For example: Required the pitch diameter of a gear having 215 teeth, 2-inch pitch. In the table, opposite 215 we find 68.4366 which would be the diameter in inches if the gear was 1 inch pitch, therefore for 2-inch pitch the diameter will be $2 \times 68.4366 = 136.8732$ inches.

The table of chords will be found useful for spacing drilled holes on a circle of given diameter, laying out gear teeth, or determining the length of the side of a regular polygon of any number of sides. In making a pattern, suppose it is desired to space off 21 teeth on a pitch circle 18¼ inches in diameter. In the table, opposite 21 we find .149. Then $18.25 \times .149 = 2.719$, the distance to be taken on the dividers. If it was required to lay off 40 holes in a cylinder head or pipe flange on a drill circle 46½ inches in diameter, opposite 40 in the table we find .0785 and $46.5 \times .0785 = 3.65$ the straight distance from center to center of the holes.

* * *

The potential power of Niagara River at the Falls, is estimated by various authorities to be from 6,000,000 to 7,000,000 horse power.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The *Sibley Journal* states that Prof. R. A. Allen, of Cornell University, has conducted tests on liquid air engines from which he finds that the best efficiency that can be obtained is about 8 per cent. of the energy expended. The expenditure of one horse power continuously for one hour results in the production of enough liquid air which, if utilized in its turn as a source of power in a perfect machine, would produce one horse power for one minute. The most efficient method of obtaining liquid air yet discovered would increase this last to a period of time of about five minutes.

The mechanical draft plant of the Union Electric Light & Power Co. to be used for lighting the World's Fair grounds, at St. Louis, will be equipped with both forced and induced draft apparatus. Generally either the forced or the induced draft is used, but in this case both will be installed. There will be twenty-six 700 H. P. boilers, equipped with automatic stokers. Four fans of the full housing type, size 160 inches, will be used for the forced draft, and will be driven by 10 x 10 vertical engines, directly attached. Two fans, also of the full housing type, 230 inches in size, will be used for the induced draft. These fans will be driven by 9 x 10 double-cylinder, double-acting upright engines, this type being selected to secure the maximum power in limited space. The apparatus will be installed by the Buffalo Forge Co., Buffalo, N. Y.

THE NATURE OF WORM THREAD CONTACT.

In an article published in the *American Machinist* on the nature of worm thread contact, Oscar J. Beale, of the Brown & Sharpe Manufacturing Co., concludes from the result of a practical experiment that the contact between the teeth of a worm wheel and a worm thread, is a line ratner than a point, as Mr. Grant seems to believe, according to the statements made in his well-known book on gears. Mr. Beale made a model worm and worm wheel, the worm being about 1½-inch pitch and the worm wheel about 3 inches diameter at the roots of the teeth, of which there were only seven. This model was carefully fitted and the ends of the 7-tooth worm wheel were cut off to a length of about 4 inches, so that the nature of the contact could be observed when the two were in contact. From visual evidence, and tests made by bluing one member and pressing the two members together, also by rotating them in mesh, while one tooth was blued, a number of witnesses came to the conclusion that, as already stated, contact between a worm thread and a tooth of a worm wheel is along a line. The models used for this experiment may be seen at the works of the Brown & Sharpe Manufacturing Co.

NEW USE FOR CARBORUNDUM.

The *Electrical Review* (London) says that a new and valuable use has been discovered for carborundum, which is manufactured at Niagara Falls by the Acheson process, and that is, covering firebrick with a highly refractory coating. Since carborundum can only be melted at extremely high temperatures, the electric furnace being required for the purpose, it follows that the temperatures ordinarily generated for smelting of ores and metals are much below its fusing point. Finely powdered carborundum is made up into a paste with waterglass, i.e, sodium silicate, or some similar binding substance; and the paste is applied by means of a brush, or otherwise, to the bricks which are intended to be used for building a furnace, or those bricks are actually immersed in the viscid liquid for a certain time. If the furnace has already been built, the paste can be painted on to the exposed surfaces, giving one or more coats as may be desired. It is stated that a layer 1-12-inch thick will protect the bricks from the attack of the highest temperature which is ever produced by combustion methods in ordinary work; examination of the bricks in such a furnace (after it had been pulled down) having shown that they had not suffered in the least. The skin of carborundum does not chip off, and is hard enough to resist mechanical injury.

ECONOMY OF REHEATING AIR.

Results of tests by students at Cornell University upon the economy derived by re-heating air were recently published in the *Engineering and Mining Journal.* Gas was used as fuel for re-heating and was also metered, thus making very accurate testing possible. The motor was a two horse power vertical engine with a shaft governor, and was provided with a Prony brake and an indicator. The series of tests was made with several one-hour runs, gage pressure varying from 57 to 82 pounds, and pressure of air raised by re-heating from 90 degrees to 320 degrees, the results being carefully recorded and tabulated. The following summary of the tests is from the *Engineering News.* For general purposes we need only give the following summary of results: (1) The net gain in economy was greatest for the lower gage pressure of 57 pounds; (2) The curve of efficiency indicates that there would be no further gain by heating the air above 450 degrees F., and with the engine used 400 degrees F. was the maximum temperature consistent with smooth running, on account of the ill effects of a higher temperature upon packing and lubricant; (3) Reheating the air relieves the engine from difficulties due to freezing of the moisture in the exhaust passages, with resulting choking; (4) The economic advantages of reheating were conclusively proved. A compressor able to supply 100 horse power of cold air to the motor, could supply 178 horse power by the use of reheaters.

USES FOR ALUMINUM.

From time to time we have noted certain interesting discoveries and processes connected with the working of aluminum; also new uses. A stock item has been new solders which were supposed to be useful for soldering this difficult metal. In general aluminum solders do not appear to be unqualified successes. This time we note a process for welding aluminum, one for hardening it, and the use of aluminum as a whetstone for sharpening edged tools. A New York woman has been granted a patent for the aluminum welding process, which appears to be exceedingly simple. The parts to be welded must be scrupulously clean and raised to a temperature of about 1,100 degrees F., at which temperature aluminum softens. Pressure is then applied until the two parts are united, the temperature being maintained constant during the process. The hardening process consists of alloying aluminum with from 2 to 10 per cent, of magnesium and then passing it several times between rollers while at a temperature of from 750 to 930 degrees F. The result is a metal that cuts and files well and still has all the ductility and malleability of pure aluminum, the hardening process merely improving its working properties. As to the use of aluminum for sharpening tools this is the alleged discovery of a German who avers that an aluminum stone is superior to the ordinary oil stone in every particular. A demonstration of this claim should not be difficult.

THE HISTORY OF THE SLIDE REST.

The slide rest which is such an important and indispensable feature of the lathe, planer, and in fact of all machine tools, was the invention of Henry Maudslay, but the logical development of the idea into the slide lathe for screw cutting and long turning, we are told, was the work of a Manchester inventor. W. H. Bailey, in an interesting historical article, "The Mechanical Inventors of Manchester," in the December issue of *Cassier's Magazine*, says that the invention of the slide lathe is due to Richard Roberts and that the first slide lathe is working in the shops of Beyer, Peacock & Co., at Gorton, England. The carriage of this lathe is on the front of the bed instead of being on top as in general practice now. Roberts brought out this improvement about 1816. The front slide lathe is again coming into use to some extent in England.

Roberts also invented an iron planer, an automatic emery grinding machine, a slotting machine, an automatc drilling

machine and a punching machine that would punch holes in plates automatically to any pattern desired. The pattern was controlled by a card which was introduced into the machine and used in much the same manner as the cards in the jacquard loom. Machines built on this plan were used for punching the plates of a number of large tubular bridges, including the Brittania, Menai, Conway, St. Lawrence, etc. The writer claims that Roberts was the inventor of the first iron planer of the type now used, but proof of this is quite impossible since the early contemporary inventors kept their inventions secret and enjoyed the advantages accruing from the use of their machines, making exact dates unknown. It is quite certain, however, that a number of planing machines were in use at about the time that Roberts invented his.

A NOVEL STEAM TURBINE PLANT.

A unique steam turbine installation is to be made by the Westinghouse Machine Co., Pittsburg, Pa., at the Cumberland Mills, Portland, Me. These mills are electrically driven, most of the current being supplied by several water power plants and the balance by a steam plant. In anticipation of trouble in the water supply, through floods, anchoring or drouth, it was decided to add another steam plant, and after considering the subject carefully a steam turbine was ordered, and it will be used solely for the purpose of a relay or reserve power. So far as we know this is the first steam turbine installation for relay purposes.

The turbine is of the Westinghouse parallel flow type, of 540 horse power capacity, and will operate under a steam pressure of 165 pounds, receiving its supply from a boiler plant located some distance (350 feet) from the unit. The steam before entering the turbine will be superheated approximately 100 degrees F. by means of an independent superheater located just outside of the building and fired by waste hydrogen gas rising from electrolytic baths used in the process of manufacturing at the plant. This gas has heretofore been a waste by-product and is here utilized for the purpose of re-evaporating condensation in the long steam line and superheating the steam to a point where the increased economy of the turbine at superheat temperature is available. The turbine will operate at a high vacuum—28 inches—which is supplied by a condensing system employing a surface condenser with gravity circulation.

The generator is mounted upon the same bedplate as the turbine and is direct driven from the turbine shaft through a flexible mechanical coupling. The space occupied by the unit is 70 square feet per horse power. The steam economy will approximate 13.5 per E. H. P. at 100 degrees superheat, which is equivalent to less than 11.0 pounds per I. H. P., as rated in reciprocating engine practice.

REMARKABLE PROPERTIES OF NICKEL STEEL.

In the November, 1901, issue of MACHINERY, mention was made of a nickel-steel alloy containing about 36 per cent. of nickel, which has most remarkable properties. The coefficient of expansion is only about one-thirteenth that of wrought iron, or .0000005 for one degree F. It is also said to resist oxidation to such an extent that polished pieces may be exposed for weeks to the air with scarcely appreciable damage, where ordinary iron and steel would quickly coat with rust. Naturally such a metal would be of great value in the arts for the construction of instruments of measurement and for the pendulums of clocks, which latter use was mentioned. This alloy was discovered in France, but the published accounts of the properties of the alloy were received with doubt in the United States, some scientists, in fact, denying that such nickel alloy properties were possible. Now, the *American Machinist* of January 8 publishes a letter from Ch. E. Guillaume, Associate Editor of the International Bureau of Weights and Measures, which affirms the statements made regarding the low coefficient of expansion, and adds some interesting facts. He says that all clocks of precision now made in Germany, are fitted with nickel-steel pendulum rods in place of the mercury compensation rod formerly used. The alloy is also being used in France and Switzerland. It is being employed for geodetic instruments and theodolites, having been adopted for this purpose by the U. S. Coast and Geodetic Survey. M. Guillaume furthermore says that it is possible by the addition of iron or nickel to the least expansive nickel alloy, to make an alloy having almost any desired coefficient of expansion. In this way "platinite" is made which has the same expansion coefficient as platinum, and also, of course, as glass. It is well known that every incandescent electric light globe made in the customary way, requires two tiny pieces of platinum sealed in the glass to form the connections with the wires and carbon filament, platinum having to be used to pass through the glass because it was the only metal known that had the same rate of expansion and contraction. The consequence is that platinum has risen in price higher than gold because of the great demand for it in the electric lamp manufacture. "Platinite" is now being quite extensively used in European factories in place of platinum.

ABOUT SUPERHEATED STEAM.

In a paper on superheated steam, read before the December meeting of the Engine Builders' Association, Mr. E. H. Foster stated that there have probably been as many as 7,000 superheaters installed in European power plants. Superheaters are installed in a variety of ways. The steam from the boiler drum may be passed through pipes so placed in the boiler setting proper as to intercept the hot gases and raise the temperature of the steam beyond that due to its pressure, or the superheater may be in a separate setting supplied with its own furnace or so arranged that the boiler gases will be deflected through it. The coils are made of seamless drawn steel or cast iron of a composition designed to stand high temperatures. On account of the diminished density of superheated steam the sizes of steam pipes and ports may be reduced about 20 per cent. from what would be necessary for saturated steam for the same power. The velocity of superheated steam in pipes should be near 6,000 feet per minute to secure a minimum drop in pressure and at the same time a minimum loss of temperature. Steam jackets are unnecessary as a feature of economy in the operation, but the author thinks that they are possibly advisable on high-pressure cylinders to facilitate warming up and starting large engines. The efficiency of superheated steam engines has been demonstrated in this country by the acceptance tests of some vertical compound engines for electric lighting service in Boston. These engines, which were of 1,200 and 2,400 horse power, showed a feed water consumption of 12.54, 12.51, and 12 pounds on full load, three-quarter load, and one-half load, respectively. The superheat was 80 degrees, 64 degrees and 48 degrees, respectively, at the high pressure admission, and 60 degrees, 67 degrees and 84 degrees, respectively, at the low-pressure admission. These engines have reheaters and steam jackets on both cylinders. Better economy would have resulted if the jackets had been left off the low-pressure cylinders. Mr. Foster says that the question of lubricating the cylinders with superheated steam is not serious, and that many have borrowed a lot of unnecessary trouble anticipating conditions that are not met with in practice. It should be borne in mind that the temperature inside the cylinder is never very high, even though the degree of superheat is considerable. If the cylinder is lubricated directly without mixing the oil with steam at the entrance point, there cannot possibly be any trouble. With good grades of mineral oil it is possible to successfully lubricate the cylinders in the ordinary way practiced with saturated steam. Poppet valves, of course, are used on the high-pressure cylinder.

A POSSIBLE SLOW-SPEED GENERATOR AND MOTOR.

In his presidential address read before the Institution of Electrical Engineers, James Swinburne referred to an interesting principle in generator and motor construction which, if certain defects could be overcome, would make possible and feasible the construction of slow peripheral speed generators and motors giving a high electromotive pressure, or in other words, a high voltage. A slow speed motor is a highly desirable feature of successful electric railway operation, and such a motor ought also to find extensive application in driving

shop tools. The cut shows the principle diagrammatically. The field has a number of N and S poles in succession, as usual in an alternator, and is laminated. The armature is drum-wound as if for a two pole field, and it has teeth which come opposite N poles on one side of the machine and S on the other. A very small movement of the armature causes the positions of correspondence to change rapidly, so that the magnetic field rotates rapidly. Thus, if there are 11 armature teeth and the speed is, say, 200 rotations per minute, the field rotates at 2,000, giving the corresponding pressure.

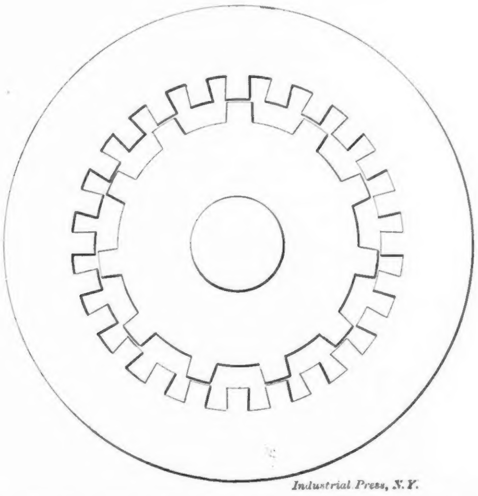


Fig. 1. Diagram Illustrating Principle of Slow-speed Generator and Motor.

If the field rotates with the armature the effective speed is 1,800; if the other way, 2,200. The difficulty in such a machine will arise from magnetic leakage. The armature reaction is also considerable. But reversing devices analogous to those proposed and used by Edison, Houston, Sayers, Atkinson, and others are available, and the machine may be made so that the armature largely excites the field in the case of a generator, and wholly excites it in the case of a motor. It is a question whether such a device as this may give us a light, compact motor.

NOISY GEAR WHEELS.

Cassier's Magazine. January, 1903. p. 459.

The difference between noisy gears and quiet gears, says Oscar J. Beale, is often so slight that an expert cannot decide, by mere inspection, to which class a given pair of gears belongs. Both kinds are not infrequently produced in the same lot, apparently under the same conditions. This is disquieting, and may lead to misunderstanding. The inspector has heard so many explanations as to how the bad work came about that he has become skeptical, and when he is told that the noisy gears were turned, cut, and fitted to place exactly like the quiet gears, his belief in narrative statements receives another shock.

A pair of gears about an inch in diameter, at 10,000 to 15,000 revolutions per minute, will sometimes set up a distressing noise, approaching the shriek of a small steam whistle, which may come from motion of the air and not from faults of construction. And so a constructor of gears has a peculiar anxiety—he is not at all concerned as to the geometrical movements of his gearing so long as it will keep quiet. He has various devices, other than the correct shaping of the teeth, with which he hopes to avoid disagreeable sounds; if he has light power to transmit, he may choose a fine pitch for the teeth; he may make his gears of brass, sometimes of rawhide, and again of compressed paper.

One of the details of construction that may cause noise is that the depth of the tooth spaces is not right. In this respect gears are oftener cut too deep than not deep enough, and it is worse to have the driver too deep than the driven gear. Another cause of noise may be that the cutting is not central. This may be shown by gears being noisy in one direction and quiet when running in the other direction. Again, the center distance may not be right; if meshing too deep, the outer corners of the teeth of one gear may strike hard against the roots of the teeth of the other gear. Still another reason for noise may be found in the fact that the frame carrying the gear shafts may be of such form and size as to give off sound vibrations.

THE VARIABLE SPEED ELEMENT IN THE OPERATION OF PUNCHING MACHINES.

Electrical World and Engineer. January 3, 1903. p. 25.

In discussing electrical power distribution in the shop, Kern Dodge says that in the case of a punching machine, it is commonly regarded as a constant-speed machine and intimates that it is usually installed with no provision for varying the speed, when as a matter of fact to get the maximum efficiency, it should be provided with means for varying the speed. To illustrate, if a punch is driven at a speed of, say, 35 strokes per minute, with light work, the operator may be able to punch a hole at every stroke, but if he gets work a little heavier, which will permit him to only punch 28 or 30 holes per minute, then he will have to miss every other stroke, which gives the machine a capacity of only 17½ holes per minute as against 28 or 30 if the motor could be slowed down to accommodate the work.

In selecting a motor for a punching machine Mr. Dodge says that it is perfectly safe to overload a motor 30 to 40 per cent. at the instant of punching, as the actual time required for the punch to pierce the metal is but a fraction of the running time, but there are other elements that cannot be overlooked, and those are principally the size, weight and speed of the flywheel. In many cases a motor which is of ample power to operate a punch when it is once in motion, will not have sufficient starting torque to overcome the inertia of the flywheel. The best way to determine the power required is to temporarily belt a motor to the punch and take careful readings of the ammeter and voltmeter in the motor circuit. But the result will be misleading if the test motor employed is much larger than the actual motor required, since the larger motor will overcome the inertia of the flywheel quickly, which would not be the case with one much smaller.

JIG FOR LAYING OUT AND DRILLING HOLES IN JIGS.

Iron Age. January 1, 1903. p. 53.

A laying out and drilling jig for locating and drilling holes in jigs is described by "C. L. G.," who says that it is being successfully used with a large universal milling machine having a vertical spindle attachment, in one of the large shops in the East (Pratt & Whitney Co.). With this fixture holes may be located and drilled in plain plate jigs with rapidity and within close limits.

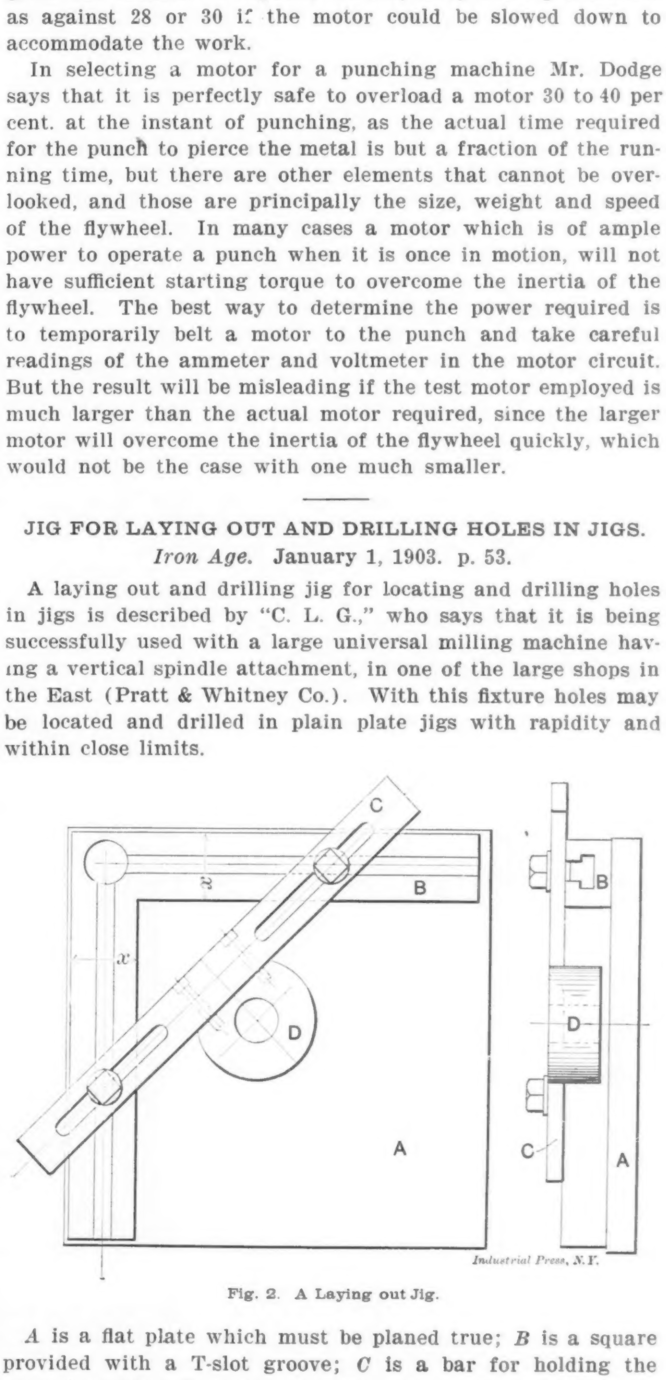


Fig. 2. A Laying out Jig.

A is a flat plate which must be planed true; *B* is a square provided with a T-slot groove; *C* is a bar for holding the ground bushing *D*. The outer diameter of the bushing *D* is ground to exactly 2 inches diameter. The dimension x on the square *B* is exactly 1 inch. Work in which holes are to be located is fastened to the plate *A*, and the bushing *D* is brought directly in line with the various holes to be drilled by means

of micrometer measurements between the edge of the bushing *D* and the square *B*, these measurements being taken at right angles to each other, either from the inner side of the square and bushing or the outer edges, according to which is most convenient. The workman takes into consideration in making measurements one-half diameter of the bushing *D* and the width of the square *x*. A standard set of bushings can be made to suit various diameters to be drilled. It is evident that this method of locating holes does not possess the refinements of means employed on some elaborate jigs, but has been found sufficiently accurate for most machine shop jigs.

THE LOCOMOTIVE SPARK ARRESTER.

Railway and Locomotive Engineering. January, 1903. p. 16.

In the course of an article on the development of the locomotive spark arrester, J. Snowden Bell says that so far as record evidence is available the "smokebox" spark arrester, that is, the type in which the netting is located in the smokebox as in the generally-followed present practice, was first proposed by J. McIlvaine, of Philadelphia, in 1833. An article contributed by McIlvaine to the Journal of the Franklin Institute, Vol. XII, N. S., 1833, illustrates the idea clearly. The netting was set in an inclined position, the top being next to the tube sheet and the exhaust pipe passing up through the middle. This design was never patented. To Isaac Dripps is given credit for the inclined deflecting sheet now placed in front of the tube sheet so as to cause a more or less uni-

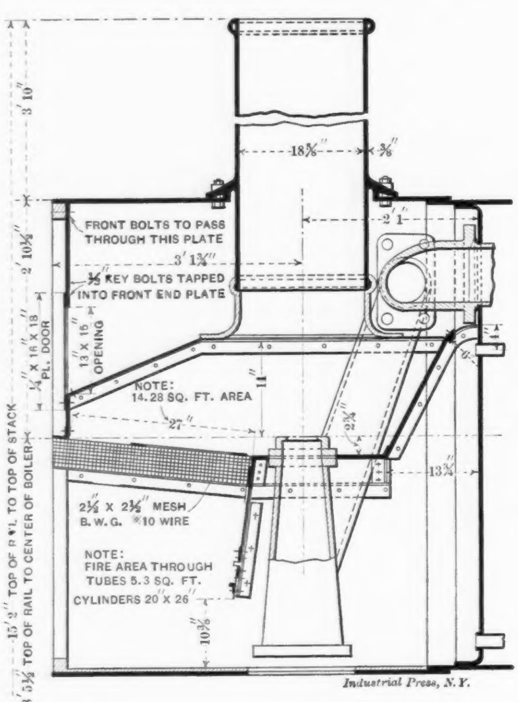


Fig. 3. Locomotive Front End for Intercolonial Engines.

form distribution of the hot gases through all the tubes. This design, which was made in 1849 by Dripps, was referred to as an "arrangement of deflecting plates in front end of boilers for burning anthracite coal on the C. & A. R. R."

The differences between the various forms of smokebox spark arresters now in use, are practically only those of detail, all embodying more or less perfected forms of the McIlvaine and Dripps designs. Mr. Bell refers to the design of front end used on 25 locomotives recently built for the Intercolonial Railway of Canada, which was designed by Mr. J. E. Muhlfeld, and says that the idea of increasing the effective length of stack by continuing it down into the smokebox, as shown in the cut, Fig. 3, was originated by Zerah Colburn in 1854, and was tried on the Columbia Railroad (now part of the Pennsylvania Railroad). The plan proposed by Colburn was to afford relief for roads having low bridges, tunnels, etc., and consisted of placing a sheet of iron across the smokebox just above the upper row of tubes and attaching the lower end of the stack to it. This not only increased the effective length of stack, but also reduced the volume of the front end, which Colburn deemed as being quite essential to good steaming qualities. Colburn's plan seems to have been abandoned, for reasons not given, which more than likely were no reasons at all more than the indifference of the mechanical department of that road.

We believe that Prof. Goss and his assistants at Purdue University have made experiments that confirm what has apparently been demonstrated by practice, i. e., that the effectiveness of a locomotive stack is increased by this expedient. Thus are old ideas revived and made useful.

PEAT FOR FUEL.

Outlook. January 17, 1903. p. 173.

In an article on the possibilities of peat, S. Power says that while New York is shivering in the grasp of a cold wave there are within two hours' distance sufficient peat deposits to keep its fires for two generations. New Jersey has peat deposits enough to last a century, Chicago is surrounded by it, the Wisconsin valleys are filled with it, Indiana might supply her neighboring states with peat fuel and never feel it, St. Paul has peat fuel beds to last her fires indefinitely. Some years ago a state geologist estimated the peat along the Hudson River, through Westchester and Rockland Counties, at over 2,000,000 cords. In fact peat is a fuel that is widely distributed over the earth's surface and has been used in a limited way for centuries, yet it is a fuel that is little known at the present time in the United States. One and four-fifths tons of air-dried peat are equal to one ton of good coal, and it burns smokelessly.

During the time of the Civil War coal became very scarce and high in some sections, and between 1860 and 1875 forty-six firms began to cut peat in New York, New England and Ohio. It was everywhere liked as a household fuel, and was an excellent steam fuel, but the supply seems to have been inadequate, or possibly peat fuel could not compete with coal, and it fell into disuse. Peat is ground and pressed into bricks on the Continent at a cost of sixty cents a ton. The writer also claims that it is being manufactured on this side of the water at a cost of $1.75 a ton. The manufactured peat is highly prized for household use in Holland on account of its cleanliness and because it takes up so little room.

SOLDERS FOR METAL.

L'Echo des Mines et de la Metallurgie. November 17, 1902.

The following solders are given as of practical value:

Soldering Tin to Cast Iron: Clean the iron with the greatest care and remove every trace of oxidation.

Coat with muriatic acid into which a little zinc shall have been previously placed.

Heat the iron to a point where the tin will melt when coming into contact with it.

Remove the piece and solder the tin in the usual way.

Solder for Copper: Take a solution of chloride of zinc and moisten the parts to be soldered, after seeing to it that they have been well cleaned, and then bring them together in the position which they are finally to occupy. Heat them with a blow pipe and allow the solution to evaporate. Then bring the tin into contact, which, as soon as it is hot enough, will melt and flow in between the surfaces. The latter will then be found to be perfectly soldered.

Solder for Lead: Scrape the surfaces to be soldered very carefully. Place between them a thin layer of lead amalgam and pass an ordinary soldering iron over the line of union. The heat will liberate the mercury of the amalgam and the lead thus set free will be found to be in a very finely divided condition and in a molten state that will serve to unite the two surfaces.

Cold Solder for Iron: Make a paste composed of

Sulphur	6 parts
White lead	6 parts
Borax	1 part

Dilute the whole with concentrated sulphuric acid.

Apply the paste and press the two parts tightly together and allow them to stand for six or seven days.—G. L. F.

INTERNAL GRINDING MACHINES.

Engineering (London), December 12, 1903. p. 767.

Joseph Horner describes a class of internal grinding machines made by some foreign machinery builders, which are adapted to grinding the holes in levers, forks, connecting rods, and other similar pieces of comparatively long dimensions which make it impossible and undesirable to swing them on the faceplate of an ordinary grinding machine of the lathe type. He first points out that for work that is to be swung

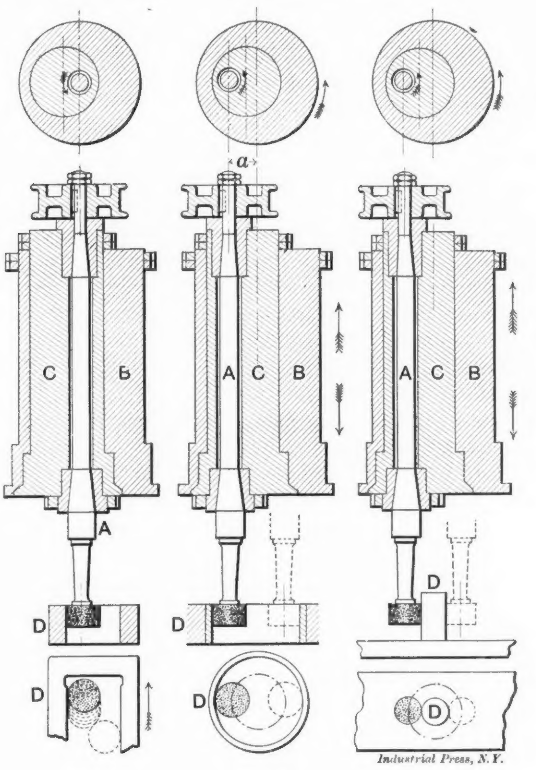


Fig. 4. Fig. 5. Fig. 6.

around a stationary axis spindle a vertical spindle machine is preferable for internal work, for the reason that work of irregular shape runs in better balance and is easier chucked by the workman, who can also better see the progress of the work. But the class of machines he describes that are of particular interest, is that in which the spindle has a sun-and-planet motion, thus making possible the grinding of holes in pieces that cannot be swung.

The illustrations, Figs 4, 5 and 6, show sections through the spindle bearing of a grinder of this class made by Friederich Schmaltz, of Offenbach-on-Main. The three views show the grinding of an internal flat surface, the grinding of a hole and the grinding of a pin. In the first case the eccentric bushing *C* is locked in the second eccentric bushing *B* so that the spindle *A* is concentric with the exterior bearing and the grinding proceeds on the work *D* the same as with an ordinary vertical machine. In Fig. 5, the bushing *C* is set at its greatest eccentricity and carries the wheel around the interior as it is rapidly driven. In the same way the exterior of the pin is ground in Fig. 6. It will, of course, be understood that the degree of eccentricity is varied by shifting the relative positions of the eccentric bushings *B* and *C*. In the machine made by Le Progrès Industriel of Brussels, Belgium, this is accomplished by a tangent screw *a*, Fig. 7, meshing in a worm, the former being attached to the exterior bushing and the latter to the interior one. This spindle is an attachment that can be used with ordinary grinding machines, either of the horizontal or vertical type, or in a lathe. Means must be provided in all machines of this type for compensating the tension of the driving belt, which would otherwise be alternately tight and slack for opposite phases of the sun-and-planet motion. In the Schmaltz machine this is accomplished by running the driving belt over idler pulleys, which are counterbalanced so as to give and take, to accommodate the sun-and-planet motion. This is feasible since this motion is not rapid, being only 50 turns per minute for the Le Progrès Industriel machine while the spindle makes 4,200 rotations. The degree of eccentricity of the spindle of the latter machine can be varied from zero up to ⅝-inch radius. This range can be amplified by varying the sizes of the wheels on holes, but not on the external surfaces of pins for reasons that are quite obvious.

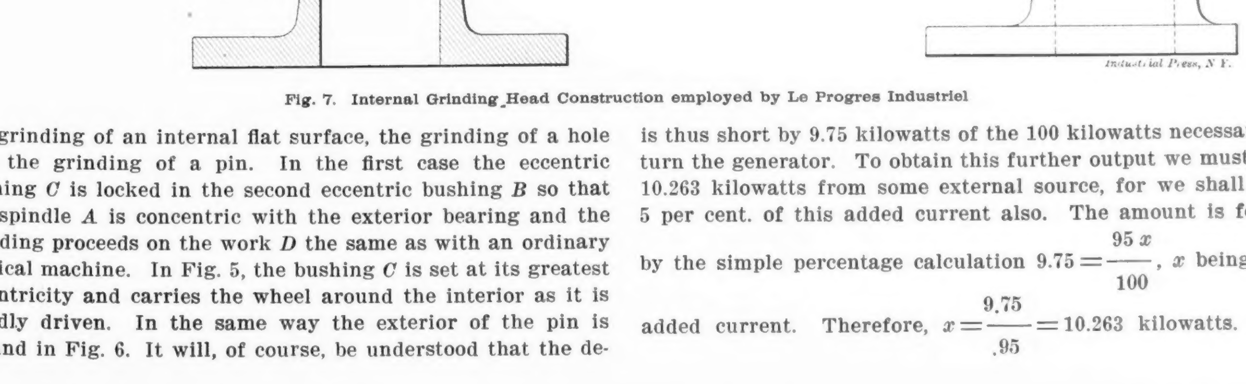


Fig. 7. Internal Grinding Head Construction employed by Le Progres Industriel

THE HOPKINSON METHOD OF TESTING GENERATORS.

Science and Industry. January, 1903. p. 28.

The usual system of testing electric generators and motors in England, is that devised by the late Dr. John Hopkinson. W. H. Booth says that in practice it is only suitable for testing machines which are made in duplicate and are alike in all particulars. The prime advantage of the method is its economy; it is exceedingly convenient and accurate.

Two similar machines to be thus tested are preferably coupled upon the same spindle. They may also be connected by means of a belt, but this introduces the element of belt friction and renders it less easy to secure exact results. The two machines thus connected are worked respectively as a motor and as a generator, the motor machine driving the generator, which in turn supplies current to cause the motor to work. The idea is thus one of the kind that is such a favorite with the "perpetual motion" man. But there is a very important difference. In addition to the current from the generator machine, which goes to drive the motor, there is a further supply of current brought to the motor from an outside source. Let us suppose that the machines are each of 100 kilowatts capacity and that they each have an efficiency of 95 per cent. Then, if the generator is revolved by a power of 100 kilowatts, it will lose 5 kilowatts by bearing friction, windage, hysteresis, etc., and will deliver 95 kilowatts to turn the motor. The motor makes use of this current at an efficiency of 5 per cent., and loses 4.75 kilowatts of the amount by similar losses and has a useful output of 90.25. The motor is thus short by 9.75 kilowatts of the 100 kilowatts necessary to turn the generator. To obtain this further output we must add 10.263 kilowatts from some external source, for we shall lose 5 per cent. of this added current also. The amount is found by the simple percentage calculation $9.75 = \frac{95\,x}{100}$, x being the added current. Therefore, $x = \frac{9.75}{.95} = 10.263$ kilowatts. We

add this amount to the 95 kilowatts we are drawing from the generator, and find a total of 105.263; and, if we multiply this sum by 0.95, we shall obtain exactly 100 kilowatts of motor output of mechanical energy. The amount of current added from an external source is thus the measure of the total loss of the two machines acting respectively as motor and as generator. By the aid of a small dynamo of 10 kilowatts capacity, we are thus enabled to test two large machines of 100 kilowatts each. Where similar machines cannot thus be obtained, a motor must be run on a brake with consequent loss of all the power, or a generator is run on a water resistance, and in either case there is great loss of energy, which means coal and money. The Hopkinson test is thus most useful and economical to manufacturers of electric machines.

The writer then proceeds to describe, somewhat fully, a test for efficiency conducted in this manner, and concludes as follows:

The Hopkinson test is the electrical parallel of a similar hydraulic test. A turbine and a centrifugal pump might be connected on the same spindle. If 100 cubic feet of water were put through the turbine in a given time and only 60 cubic feet ran to waste, the pump returning 40 cubic feet to the source of supply, we should say that the combined efficiency of the two machines was 40 per cent.

FAN BLOWER FOR THE CUPOLA FURNACE.

Abstract from Paper read by R. B. Hayward before the Pittsburg Foundrymen's Association. January 5, 1903.

For a considerable period of time in early foundry practice the blowing engine such as is now used in the manufacture of Bessemer steel and in blast furnaces was used ror blowing the cupola, but this was displaced by the rotary or positive pressure blower having rotating impellers. This type of blower held undisputed sway until the development of the centrifugal fan blower. The fan was introduced by Sturtevant about thirty years ago, who was the pioneer manufacturer of blowers in this country and in the world.

There are two general types of fans for moving air, one being the propeller or disk fan, which discharges air in lines parallel to its axis, and the other being the peripheral discharge fan with inclosing case. The disk wheel type of fan is incapable of moving air against any considerable resistance, and is, therefore, without value for the cupola furnace, although well adapted to moving large volumes of air against low pressure.

The peripheral discharge fan is built either as a volume or pressure blower, that is, to discharge a large volume of air against a low pressure, or a small volume against a higher pressure. Both forms are essentially alike, the design being modified to suit its particular requirement. In either case the mechanism consists of a blast wheel made of radial arms having floats fastened to the ends, which present their flat surfaces for moving the air. The wheel is ordinarily inclosed in a case having an outlet, the whole forming a means for directing the blast. The maximum amount of air can be moved with a wheel when it has no case, but this form can only be used for special purposes where it is not necessary to give the blast any special direction. The distinction between a volume blower and a pressure blower is that the former is designed to move a large volume of air at a low pressure, and the latter to move a relatively small volume at a higher pressure, which may be as high as 20 ounces per square inch. The points of difference in construction between a volume blower and a pressure blower having the same diameter of wheel, are that the volume wheel is wider and that the pressure wheel has bridging pieces spaced at short intervals on the periphery between the extremities of the blast wheel arms, their use being to prevent the air rolling back upon itself at high speeds. A pressure wheel is also made as narrow as it can be consistently with a given diameter.

Air is delivered from the tips of a peripheral discharge fan, tangentially by centrifugal force, an equal amount entering at the center of the wheel to replace that discharged. The volume of air delivered varies directly as the speed, the pressure as the square of the speed and the power as the cube of the speed. That is to say, multiplying the speed by two, multiplies the volume by two, the pressure by four, and the power by eight. A thorough understanding of these conditions would often save much trouble for both the purchaser and the salesman. If the speed is increased over that specified, the power required may be enormously increased for a slight increase of speed. In general where a fan has been installed and it afterward becomes necessary to increase the volume of air, it is cheaper and better to put in another fan than to speed up the old one. The pressure required for foundry practice varies from 4 to 14 and 16 ounces per square inch, depending on the size of the cupola.

LARGE STOP VALVES FOR HIGH-PRESSURE STEAM.

Abstract from Paper read by J. H. Gibson before the North-East Coast Institution of Engineers and Shipping, December 12, 1902.

The author referred to the well-known difficulties encountered in the use of ordinary large stop valves and high-pressure steam, especially the double-beat or equilibrium valves such as are generally used for the throttle valves of locomotives and in the main steam pipes of large marine engines. The construction of these valves, which makes them easy to open, unfortunately introduces a condition favorable to leakage. No matter how carefully the two seats of a double-beat or double-poppet valve are fitted when cold, they will be distorted somewhat out of truth by the heat and pressure of the steam, and the same also holds true of the valve case, so that leakage is almost inevitable, especially with the larger valves. To force such valves to their seats with great pressure is out of the question with man power alone, so on the large ocean liners the main actuating valve is commonly actuated by a separate engine driving worm gearing, the idea being to compensate for the defects of the valve by main force. This, as the author points out, is scarcely mechanical or in accordance with good engineering. He also says that the annoyance of leaky regulating valves is a very real one to the engine room staff of a steamship. It is not always permissible to close the boiler stop valves or even the shut-off valves usually fitted in the main steam pipe at the engine-room bulkhead, as under certain circumstances the engines may be stopped for hours in "stand-by" condition, ready at a moment's notice to move "ahead" or "astern." Consequently the steam is often allowed to leak through the engines; and the cylinder drains must be kept open continuously, adding greatly to the discomfort of the engine-room and increasing the danger of pressure accumulating in the receivers, thus blocking the engines when a sudden call is made.

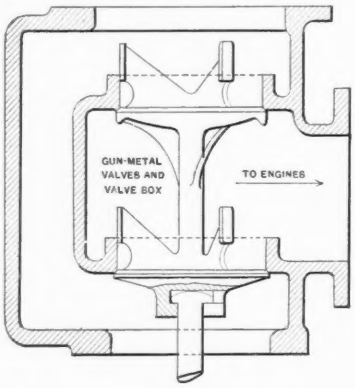


Fig. 8.

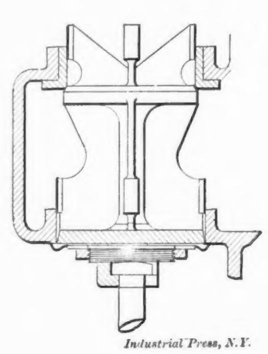


Fig. 9.

Mr. Gibson then described the valve made by his firm for the starboard engines of a torpedo boat destroyer of 6,000 indicated horse power, which was tested alongside of the valve made for the port engines. The valve for the starboard engines is shown in Fig. 9, and its distinguishing feature is a flexible disk of hard-rolled bronze, bearing on the larger seat, the disk for the smaller seat being made solid with the stern as in the usual manner. This valve stood a cold hydraulic test of 500 pounds per square inch and a steam pressure of 250 pounds, with no leakage whatever. The solid disk valve leaked badly with steam, although it was made with care and the seats were jammed down with the aid of a lever. In the improved valve any distortion of the valve or seats is compensated by the flexible bronze disk, which accommodates itself to changes in shape and permits the solid

valve disk and seat to close tightly. The larger valve consists of a flexible disk of hard-rolled bronze, the smaller valve being solid and of the usual type. The distance between the valve seats is slightly greater than that between the valves. Consequently, in closing, the flexible valve engages its seat first. The solid valve is then pressed home on its seat by the unbalanced steam pressure acting on the central area of the larger valve, assisted by the handling gear. Any distortion between the valves and seats is thus taken up by the flexible disk, which readily accommodates itself to its seat, leaving the smaller solid valve free to bed itself in its own seat.

In the improved valve, shown in Fig. 9, some trouble was subsequently experienced due to the curled edge of the flexible disk cracking, and various other materials and forms, as shown in *A, B, C, D, E*, Fig. 10, were tried, the experiments finally culminating in the adoption of a perfectly flat disk, as shown

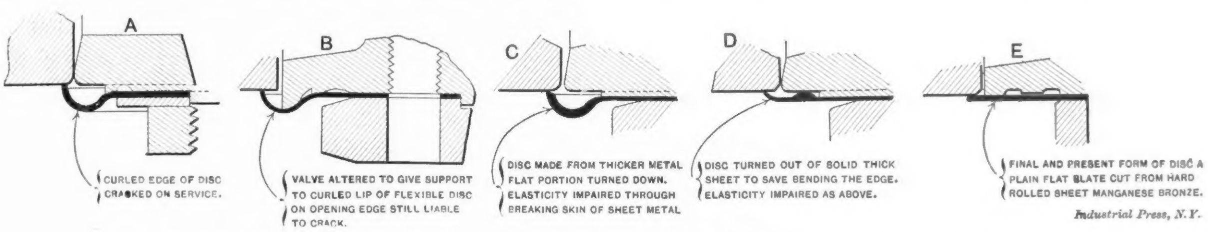


Fig. 10. Forms of Disk Construction tried in Experiments; the one shown at E is the one finally adopted.

at *E*, bearing on a raised lip on the valve seat. Should this disk take a permanent set, it may be turned over and used in that position. Apparently the disk retains its flexibility longer when the skin left on by the rolling process remains unbroken. But the amount of spring allowed is reduced to a minimum to relieve the disk of buckling action as much as possible. We find that 1-64-inch of spring is ample in most cases, but this allowance may have to be slightly increased should the valve expand so much more than the valve box that the difference allowed is overtaken. However, a buckling effect of even 1-32-inch in a 12-inch disk is scarcely perceptible, and as the number of changes from flat to buckled is comparatively few and not constantly intermittent, the disk lasts indefinitely.

KEROSENE AS A DISINCRUSTANT.

L'Echo des Mines et de la Metallurgie, November 17, 1902. p. 1389.

Petroleum oil has been used as a disincrustant for a long time. According to the figures furnished by Mr. Fritz Krauss, the engineer of the Austrian Society of Steam Boiler Owners, in every battery of six boilers one should always be out of commission for cleaning. The loss of heat due to the cooling off and reheating of a boiler amounts to about 1 per cent. of the total annual coal consumption, while the work of cleaning may amount to 3 per cent. of the total cost for coal, to which should be added 2 per cent. for interest while the boiler is out of service, making the total annual cost for the cleaning of the boiler about 6 per cent. of the annual expenditure for fuel. To this it is necessary to add the losses of heat due to incrustation, which may amount to from 4 to 5 per cent. of the fuel account. From this it appears that the cost of fuel is increased from 10 to 11 per cent. through these various causes. And it may be added that, in the case of small plants these expenses and annoyances may be considerably increased.

The use of petroleum oil, however, makes it possible to cut them down very considerably. Its action belongs to the physical-mechanical actions. It prevents the adherence of the deposits to the sheets and makes them soft; in contact with water it forms an emulsion and prevents the agglomeration of the particles of lime. Simply washing serves to clean the boiler. In a boiler that is already coated with scale, it is possible to detach the same by simply injecting petroleum. There are, however, some disadvantages in this, in that a badly cleaned boiler into which kerosene has been injected, or where it has been used before cleaning was done, is apt to cause an overheating of the sheets and perhaps a fire-crack. Thus trouble is experienced chiefly with outside fire boxes. The petroleum oils should, therefore, never be used in boilers having external fireboxes, if the former are coated with a scale. This accident need not be feared when the firebox is beneath as the sheets are much better located with reference to the fire. It is evident that the method cannot be used if a strictly pure steam is required.—G. L. F.

PROTECTION OF SUSPENSION BRIDGE CABLES.

Engineering News, November 13, 1902.

In the *Engineering News* for November 13, is an article by Wilhelm Hildenbrand, engineer for the cables of the new East River Bridge, New York, in which he tells about the waterproof wrapping for the four large cables which are to support the bridge structure. For the past fifty years or more all large wire cables have been protected from atmospheric influences by a method originated by John A. Roebling, the pioneer of wire suspension bridges. At the time of the early bridges built by Roebling, the use of steel for building purposes was unknown, and galvanizing was not invented. Bright iron wire was used which was treated in the following manner:

Each ring of wire was dipped twice in boiled linseed oil, the second dipping being done after the oil of the first dipping was thoroughly dried. These two immersions in oil, after the latter became perfectly dry, surrounded the wire with a gummy film, to which a third coat of oil was added by passing the wire through an oil-saturated sheepskin, when it ran off from the drums for cable-spinning. After a number of wires were united and tied into a "strand" the latter received another thorough soaking of oil, which added a fourth coating and gave assurance that any spot of a wire from which the oil film might have been scraped off during cable-spinning was covered with at least one coat of oil.

A cable in which every wire is prepared as indicated above may be considered tolerably rust-proof for years if kept properly painted, but permanent safety can only be obtained by excluding all moisture from the interior of the cable, which requires a watertight and airtight covering. Such a covering was given by Roebling to all of his cables by a tight and continuous wire wrapping over the whole length of the cable, exempting only those parts which rested in the saddles or passed around the end shoes. The wrapping was put on with a specially constructed machine, worked by hand, preceded by strong clamps which squeezed the bundle of strands into a cylindrical form of the required diameter. The wrapping wire was underlaid with a thick coat of white lead mixed with linseed oil, and a similar coat was applied to the top of the wrapping. After that the cables were painted with metallic or oxide paint of any desired color. The paint was put on thick enough to fill the hollows between wrapping wires, making the surface of the cable practically smooth and giving it the appearance of a solid cylinder. The cables of bridges that have done service for over 40 years have been found to be in a perfect state of preservation when treated by this method.

When it came to the construction of the first Brooklyn Bridge which was exposed to salt water air, Mr. W. A. Roebling, the engineer, felt apprehensive about his father's methods of protection and it was decided to have all the wires galvanized. In taking up the description of the work on the new Brooklyn Bridge Mr. Hildenbraund gives an extended account of the various schemes thought of, and of the one finally adopted. The plan of the original Roebling has been found by experiment to work so well and is so simple that it may justly be questioned whether a mistake has not been made in the measures taken for the protection of the cables of the new bridge. While it is unquestionably true that Roebling's method may not be the only satisfactory one, there is nothing

to show that the new method is superior. It was planned at first to give the strands two coats of linseed oil and afterward to coat the completed sections of the cable with a patented preparation known as "cable shield." It was then to be clamped and tied with wire wrappings and finally covered again with cable shield. Finally the whole was to be encased in a sheet-iron covering made in sections, bolted together. The cable shield preparation was found to be too stiff to work properly, however, and another patented preparation, a slushing oil, was tried; but it was found that it would not give a permanent and perfect coating as it had a tendency either to evaporate or to deteriorate under the influence of the gases from the stacks of passing steamers. Finally it has been decided to adopt what is known as a cable compound, similar in its nature to a high-grade metal paint. The strands will now be treated first with the linseed oil and then each section of the cable will have the additional coating of slushing oil and graphite above-mentioned and the whole will be wrapped with a heavy coating of duck which is cut into strips and wound around the cable, about as a physician bandages an arm. The durable metal coating is next applied to the duck covering and finally the sheet-iron covering encases the whole.

While it is expected that this method will give satisfactory results, the fact remains that it is more or less of an experiment and that the experiment is being tried on a very expensive structure.

TOOL FOR CUTTING OFF PACKING RINGS.

Railway and Engineering Review. December 20, 1902. p. 905.

The illustration, Fig. 11, shows a multiple cutting off tool used in the shops of the Michigan Central Railroad in making air-pump metallic packing. The tool is tapered so that the rings are cut off consecutively thus avoiding the trouble that would naturally result if all were cut off at the same time.

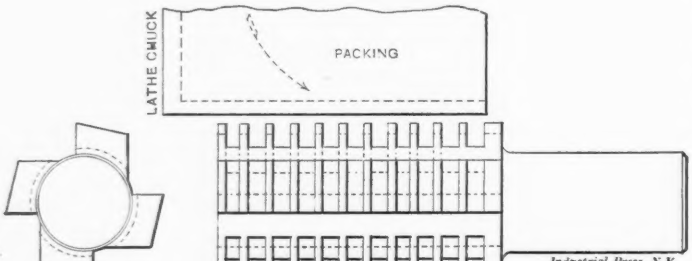


Fig. 11.

This tool is used in a small turret head that is set on the tool block of an ordinary lathe, the turret taking the place of the tool-post. The shank of the cutting-off tool fits into one of the holes of the turret. It will, of course, be observed that the tool really consists of four sets of cutters, any one of which may be brought into use as the others become dulled.

* * *

A balloon constructed by the French War Department for crossing the Sahara is to carry six pigeons, whose safe passage will be supposed to show the feasibility of the plan. As the trip may require four or five days, the recording thermometer and barometer have clockwork to operate five days; and a camera, carrying a long strip of film, is so arranged that exposures will be made by clockwork at intervals of fifteen minutes during the time. Leakage is to be balanced by water ballast, released by a valve when the ground is touched by a ball hanging from the car.

* * *

An alloy of 18.87 per cent. aluminum and 81.13 per cent. antimony is, says the *Aluminum World*, a marked exception to the general rule that alloys are more fusible than the least fusible metal they contain. Both aluminum and antimony melt somewhere near 1,160 degrees F., but the alloy melts only at 1,976 degrees F. Most alloys are denser than their constituents; this alloy is less dense. To put the matter into figures to illustrate, 7.07 cubic inches of aluminum alloyed with 12.07 cubic inches of antimony produces 23.71 cubic inches of alloy, or an increase of volume of 4.55 cubic inches.

SUPERHEATED STEAM FOR TURBINES.

Editor MACHINERY:

In the *Engineering Review* of your December number was an abstract of a paper read before the Detroit meeting of the American Street Railway Association upon "The Adaptability of the Turbine to Superheated Steam."

In speaking of the advantage of superheat, from a thermodynamic point of view, the writer of the paper in question assumes that the well-known law of thermal efficiency, that is, $\frac{T_1 - T_2}{T_1}$, is applicable, and uses the temperature of the superheated steam in this expression, implying that it is the measure of efficiency in the case. As a matter of fact this expression—which, of course, is the efficiency of the ideal Carnot cycle—is true only when all the heat is taken in by the working fluid at the *highest* temperature, and *all* rejected at the *lowest* temperature, these two processes being therefore, isothermal. The expression $\frac{T_1 - T_2}{T_1}$ is, then, not even a rough approximation as a measure of the efficiency.

In the cycle of operations, including superheat, by far the greater part of the heat is taken in at temperatures lower than the ultimate temperature of the superheated steam, the greater part, of course, being absorbed in converting the water into steam. It naturally follows, then, that the use of superheated steam is, thermo-dynamically, of but very little advantage, in any class of heat engines. It seems that the knowledge some people have of the steam turbine is that it is a machine consisting of a wheel, a casing around the wheel, and a jet of steam causing it to revolve. If these were its only necessary elements we might admit, with caution, that "the range of superheating is limited practically only by the superheater." It should be remembered that steam at high temperatures not only burns up the lubrication, but destroys the packing of stuffing boxes and has a chemically corrosive effect upon brass and copper. Bearing this in mind and considering that steam is supplied to the turbine in much the same way as to the engine, and that this supply is increased and diminished with the load (thereby involving, of necessity, some form of regulating valve) I think statements of a broad nature like that quoted above should be made less recklessly.

Superheated steam can be considered, then, but little, if any less objectionable in steam turbines than in reciprocating engines. At the same time its thermo-dynamic advantage is no greater and its corrective influence is much less, since the turbine is not possessed of the same faults as the ordinary engine.

The point I wish to emphasize is, that while the use of moderately superheated steam is, in general, beneficial, rather than otherwise, its advantages are liable to be overestimated.

R. M. L.

[It is perfectly true, as our correspondent states, that there is little thermo-dynamic gain from the use of superheated steam in an engine cylinder. The increased efficiency due to superheated steam comes from the reduction in initial condensation and consequent re-evaporation. In the steam turbine there is no alternate heating and cooling of the surfaces in contact with the steam, and no condensation from this cause; yet there is an advantage from the use of superheated steam in turbines, as shown by many tests. Mr. Parsons estimates that 90 degrees superheating will reduce the water consumption of a turbine about 12 per cent. and recent tests of a De Laval turbine show a saving of nearly 9 per cent., with 84 degrees superheating. While we know of no experiments to show just why this saving is effected, it may be due, in part at least, to the increased velocity at which the superheated steam would impinge against the blades of the wheel. It does not appear to us that there need be serious trouble in lubricating the admission valves of a steam turbine using superheated steam, and we believe, contrary to our correspondent, that the turbine is admirably adapted for superheated steam. In fact, Mr. E. H. Foster testifies in an item to be found in the "Engineering Review" of this number that there need be but little trouble in a steam engine cylinder, if the oil is introduced into the cylinder direct, instead of with the steam in the usual way.—Editor.]

STEEL AND ITS TREATMENT.—6.

CASEHARDENING.

E. R. Markham.

The subject of casehardening is one that receives even less consideration in the average shop than the hardening of tool steel, if that be possible. According to the generally accepted idea of the process, it consists essentially of making the outside of a piece of wrought iron, or of machine steel hard while the interior remains soft. Speaking narrowly, this is true; but if properly understood, casehardening requires as much study, and calls into play the reasoning faculty to fully as great an extent as the hardening of tool steel. Formerly when wrought iron was used if articles required simply a surface the hardening operation was simple, compared with the present where a low grade of steel is used, because it is cheaper and is less costly to machine, and if properly treated answers the purpose much better than wrought iron.

The method commonly used when hardening articles such as screws, nuts, etc., which simply require sufficient surface hardening to save tearing out the edges of screw driver slots, or to keep the corners of nuts from becoming rounded or mutilated, consists in heating the article red hot, sprinkling on it a little cyanide of potassium, or yellow prussiate of potash. Now place the article in the fire again, heating to the desired temperature and quenching in a bath of clear water, brine, oil or any liquid that will absorb the heat quickly. This method is extensively used and answers where but a few pieces are hardened, but is very unsatisfactory and costly for many pieces.

As it is necessary oftentimes to harden a few pieces by this method, a hint may not be amiss. For best results use *chemically* pure cyanide of potassium. Pulverize it, and keep it in a tin or sheet-iron box having a perforated lid, the object of the perforated lid being that the cyanide may be sifted onto the work in any desired quantity. If colors are desired on the hardened article it will be necessary to polish the surfaces nicely and have them free from grease or dirt; for while the grease would burn when the article is heated, the surface would be stained and consequently would not color nicely. When colors are wanted, it is necessary to use clear water; that is, clean. Soft water produces better colors than hard water. Work cannot be colored if dipped in dirty or greasy water.

If especially nice colors are wanted they may be obtained by following the directions herewith: When the work is ready to dip, place a piece of ¼-inch gas pipe in the bath with its end nearly at the bottom of the bath. Blow through the pipe, passing the work down through the mixed air and water; for while work that needs coloring should not be exposed any longer than necessary to the action of the atmosphere, yet the injection of air into the hardening bath results in the most beautiful colors imaginable. Another factor that must be considered if colors are wanted is the means of heating. If the article is heated in a dirty fire pretty colors cannot be obtained. If the article is exposed to the products of combustion in the fire, or the oxidizing action of the air, colors cannot be obtained, or at least, not as pretty colors as when the article is heated in a tube, a muffle furnace or some receptacle that removes it from the influences mentioned. Where a number of small articles that require coloring are to be hardened, melt and bring to a red heat, in a small iron dish, a sufficient quantity of cyanide of potassium to permit immersing several pieces of work at a time. These may be allowed to remain in the molten cyanide for a length of time that insures satisfactory results; the longer the articles are in the cyanide the deeper will be the hardened surface. When they are ready to quench, remove and plunge in the bath as mentioned. Many shops have large cast-iron or wrought-iron crucibles, heated by fires specially designed for the purpose. The work, if large, is suspended in the cyanide by means of wires, which are made in the form of a double hook, one end of which passes around the work, or through some hole in it, and the other end projects over the upper edge of crucible. It will be seen that in this manner quite a number of pieces may be suspended in the crucible at a time. Where much of this class of work is done it is advisable to dispose in some manner of the fumes of the molten cyanide, as they are very injurious to the health. The reader must bear in mind that cyanide of potassium is a *violent poison* and extreme care should be exercised when using it. Cyanide of potassium, unlike lead, is lighter than iron or steel and consequently articles placed in it sink to the bottom instead of floating on its surface, as is the case with lead; for this reason the pieces are suspended by means of wires, or placed in wire cloth baskets. These baskets must be made of *iron* wire. Do not use galvanized wire, or wire with any form of lead or any metal whose fusing point is so low that it will melt at the heat to which the articles are subjected; otherwise the metal will fuse and deposit itself on the work, thus ruining it. From the foregoing it will also be readily understood that no solder should be used in constructing the basket.

If the basket holding the work is dipped in the water it must be thoroughly dried before being placed in the molten cyanide, or the moisture will cause the cyanide to fly, and this, owing to the poisonous nature of the chemical, will produce a very sore burn wherever it strikes the flesh. The same care must be exercised when using the hooks, which should be thoroughly dried before placing in the molten mass. When work is hardened in large quantities by this method it is necessary to provide extra hooks and baskets, to avoid delay while the moistened ones are drying. This method is used quite extensively for casehardening steel of low grade, and still more commonly for heating articles of tool steel for hardening. In many shops it has supplanted the crucible of red hot lead as a means of heating taps, reamers, and similar tools.

The more common method of casehardening, for work in large quantities, consists in packing the articles in iron boxes with carbonaceous materials, placing in a furnace and subjecting to heat for a sufficient length of time to insure the penetration of carbon to the desired depth. The carbonizing element most commonly used is granulated raw bone. This is used either alone or with an equal quantity (volume)

Fig. 3

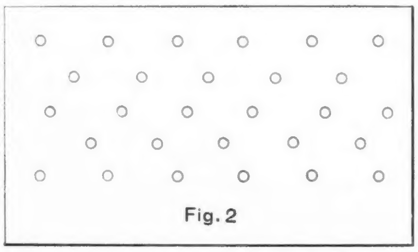


Fig. 2

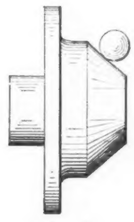


Fig. 4

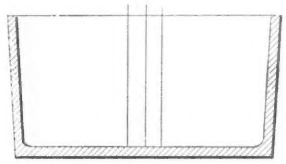


Fig. 1

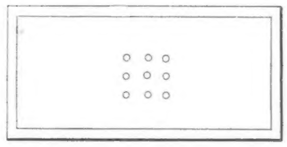
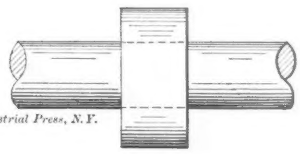


Fig. 5



Industrial Press, N.Y.

of granulated wood charcoal. It is customary in many shops to place the box of work in the oven or furnace, leaving it there a certain length of time. This method is open to serious objections, for some days the furnace will heat more readily than others, or the box of work will not absorb heat as quickly one day as it will another. Consequently uneven results follow. In order to insure uniform results the writer, for many years, used a system of test wires, which he found furnished a reliable means of ascertaining when the box was heated through. A half dozen ¼-inch holes are drilled through the center of the cover of the hardening box, and through these holes a piece of 3-16-inch wire is placed, the wire reaching to the bottom of the box and projecting about one inch above the top of cover, as shown in Fig. 1. When the box has been subjected to heat for a length of time (according to one's judgment) to become heated through, one of the test wires is removed by means of a pair of long tongs, or a pair of ordinary length, with a piece of gas pipe slipped over each leg to give desired length. If the wire shows red, time from then; if not, wait a few minutes and draw another, and so continue until one is drawn that shows red its entire length.

As previously stated, the subject of casehardening and its possibilities are very imperfectly understood by the average mechanic. A hardened surface is not the only thing desirable at times. If the work simply requires a hardened surface to resist frictional or similar wear the operation is comparatively simple, provided the strength of the piece is not to be considered. In such cases the articles are packed in a box with granulated raw bone and charcoal, in equal quantities, and run in the furnace for a sufficient length of time to carbonize to the depth desired. Then the box may be removed from the furnace and inverted over the bath, provided the pieces are of a size and shape that insures their becoming sufficiently chilled before reaching the bottom of the tank. Should they be too large for this to be accomplished it is advisable to wire them before placing in the hardening box. They may then be removed from the box by means of the wires and immersed in the bath, moving the work around in the bath to bring it in contact with the cooler portions, and thus prevent a cushion of steam from keeping the liquid away from the work. If the pieces are small they may be dumped directly into the bath, but in such a manner that the contents of the box will not go into the bath in a mass, or the liquid will not act on the surface of the iron. The work may be sifted out of the box, or wires may be arranged to scatter the work, as shown in Fig. 2.

Should the article be somewhat slender or weak, and it be desirable to get a hard surface and a tough interior, it may be packed in a box as described, using a mixture of equal parts of charred leather and granulated charcoal. Run as described, and quench in a bath of raw linseed oil. If the articles are large it will be necessary to wire them, dipping in the oil by means of the wires; if small, the contents of the box may be emptied into a sieve having a handle, as shown in Fig. 3. This sieve must be made of sheet iron throughout to prevent its catching fire from the red hot pieces of work. The packing material will fall through the perforated bottom and the work may be dumped from the sieve into the oil. The object in using charred leather in preference to bone, for work that must be strong, is that bone contains phosphorous which is taken up by the iron or steel and this, while it is a hardening element, causes the steel to become exceedingly brittle, especially when in combination with carbon. Where the pieces must be quite tough, but no great strength is required, bone may be used. Dump in oil. If extreme surface hardness is desired, without having the piece brittle, pack in charred leather and dump in water. When hardening screws made of Bessemer steel wire, it is advisable to use expended bone—bone that has been used before—rather than raw bone. This will cause the work to be hard enough without being brittle, as when raw bone is used. If colors are desired it is advisable to char the bone *before* using, which may be done by filling an iron box with raw bone, placing the cover in position and sealing with fire clay. After this has thoroughly dried, place the box in the furnace, allowing it to remain until the contents are charred. If the furnace is large the box may be put in when the day's work has been removed and the fire extinguished; for the walls of the furnace will in all probability retain the heat long enough to accomplish the desired result. Should the furnace walls be light, however, and not capable of retaining sufficient heat the fire must be run for a sufficient time to char the bone the desired amount. Articles packed in charred bone will not be as brittle as when raw bone is used.

When packing work in the box, place about 1½ inches of packing material in the box. On this put a layer of work, keeping the pieces about ½-inch from one another in the box, or 1 inch from the walls of the box at any point. Cover the layer of work, to a depth of ½ inch, with the packing material, working it well between the pieces, and tamp down. Now put in another layer of pieces, and so continue until the box is filled to within 1½ inches of the top, when the box may be filled with the packing material. Put the cover in position, seal the edges with fire clay mixed with water to the consistency of dough, but before putting the box in the furnace run the test wires down through the holes to the bottom of the box. Carbon is supposed to penetrate iron at the rate of about ⅛-inch in 24 hours. Therefore, in order to harden to the depth of 1-32-inch it would be necessary to subject the article to heat for six hours after it was red hot. This can be ascertained by means of the test wires.

Selection of Stock.

A factor which should receive the greatest consideration, and which seldom gets any, is the stock that must be used to obtain certain results. If a hard surface is the only thing to be considered, almost any stock will do. If, however, the article is to be subjected to great strain, it is essential to select a stock low in percentage of harmful impurities, and containing carbon in the proper proportion to harden the article sufficiently to make it capable of resisting the strain to which it will be subjected. The extra surface hardness required may be procured by the steel absorbing sufficient carbon from the packing material to produce the desired result. Articles which must resist shocks, blows, or strains of any character should be made from open-hearth steel rather than from Bessemer steel; the former runs much more uniform as regards percentage of impurities.

When the article to be hardened must resist the action of blows, harden it in a manner that will produce a fine compact grain; it will stand up much better thus than if the grain were open. This can be accomplished by packing the articles as described, letting them run the necessary length of time to allow the carbon to penetrate to the desired depth. Then the boxes may be taken from the furnace and allowed to cool off. When cool, the articles may be removed and hardened in the same way as those made of tool steel—by heating separately in the open fire, or by being heated in red hot lead, or being placed in a box without any carbonizing material, heated to a low red and dumped in the bath. The second heat, without carbonizing material, produces the fine grain. In this manner a low grade steel may be given a grain as fine as the nicest tool steel. This process is familiarly known as the Harveyizing method. It is used where the surface is subjected to the action of blows, or where a small portion of the surface is to be subjected to pressure or wear. Take, for example, the surface of a bicycle cone such as shown in Fig. 4, where the ball bears on a very minute portion of the surface. If the cone is made of a low-grade steel and hardened by the method familiarly known as casehardening, the grain of the steel is open, and consequently when the ball bears on the surface over one of the pores, the wall caves in, leaving the small hole in the surface. It is supposed by many that these holes are caused by the ball picking up pieces of steel that compose the surface of the cone. Such, however, is not the case; the surface caves in, not having any backing, but when the grain is compact this cannot happen. When cutting tools are made from machinery steel it is best to pack the work in charred leather, running them for a sufficient time,

allowing them to cool and proceeding as previously described. The grain will be fine and compact, and the tool hard and strong. The writer does not advocate the use of a low-grade steel in place of tool steel for tools, but claims, from experience, that many times excellent results follow if care is used in selecting the steel, and if the directions given are followed.

When it is considered necessary to harden a portion of an article and leave the balance soft, it may be accomplished by protecting the portion to be soft with something that will prevent the carbon from coming in contact with the steel at that point, as steel cannot harden unless the surface is carbonized. The portion that is not protected will become carbonized, and consequently will harden if plunged in the

Fig. 6.

bath when red hot. There are various methods pursued when a portion is not to be hardened. A very common one consists in placing a collar over the portion, as shown in Fig. 5, which, however, is a very costly method when many pieces are to be hardened. Another consists in protecting the surface with fire clay mixed with water, adding a sufficient quantity of plasterers' hair to hold the mass together. Sometimes the piece is subjected to the action of carbon on its entire surface; but the portion that is desired soft is covered to protect it when dipped in the bath. In this case the surface is carbonized but does not harden, because it is protected from the cooling action of the water. As an example, take the crank axle shown in Fig. 6. The axle is subjected to the action of carbon in the usual manner. In order to insure fine grain in the portion where the ball is to run, the axle is not hardened at the heat the steel is carbonized at, but is given the second heat to refine the grain. The axle is taken with the tongs shown in Fig. 7, which effectually protect the enclosed portion from the cooling action of the bath.

Another method used in local casehardening consists in machining to size the portions that are desired hard, before carbonizing, leaving the balance of the piece large. It is

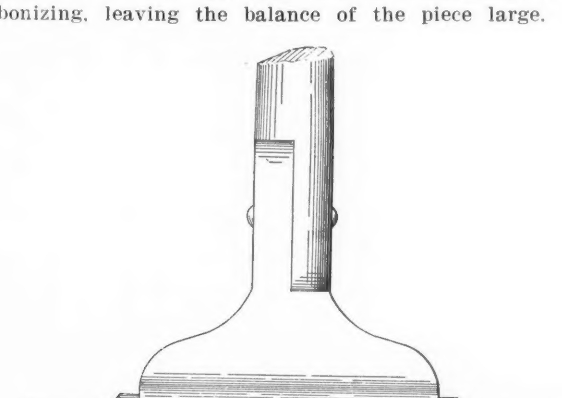


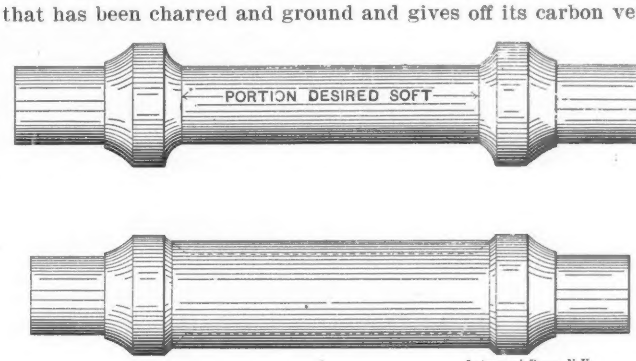
Fig. 7.

then carbonized and allowed to cool, after which the balance of the piece is machined to size and the article is heated and quenched in the bath. The parts that were machined to size before carbonizing will become hard, while the other portions having been machined below the carbonized surface will be soft. As an example we will consider the axle shown in Fig. 8. It is first machined as shown in Fig. 9. Then it is carbonized and machined to size, as represented in Fig. 8. After being machined to size it is heated red hot and dipped in the bath. The portion turned off after carbonizing will be soft while the balance will be hard.

Still another method which works very nicely but is not generally used on account of its cost, consists in plating with nickel the portion desired soft. As carbon cannot penetrate nickel the plated portion will be soft while the balance of the article will be carbonized and consequently will harden when dipped in the bath.

When bone is used as the carbonizing element it should be saved and dried, for it can be used again for hardening small articles and pieces which need not be very hard. It can also be used for work that must be hard by adding an equal quantity of raw bone. Leather that has been used should also be saved, as when mixed with an equal quantity of fresh material it works even better than the fresh material used alone.

Granulated raw bone may be purchased of any size granule. The small sizes are used for work that is not to be subjected to heat for a very long time. The deeper the hardened surface must be, the longer the article must be exposed to the action of heat and consequently the coarser the bone should be. When articles require hardening very deep it is advisable to use a coarse bone and run for 10 or 12 hours. Then allow it to cool, repack with fresh material and run for an equal period again. This is preferable to the method of exposing the heat for too great a length of time at once. If extra good results are required it is advisable to use bone-black instead of raw bone. This is a prepared form of bone that has been charred and ground and gives off its carbon very



Figs. 8 and 9.

readily. Still better results are obtained by the use of hydrocarbonated bone, which is a form of bone-black treated with oils.

Charred leather may be purchased in the open market. It is apt to be anything but reliable, however. Best results are obtained if the leather is charred in the factory. Do not use thin, light pieces as there is nothing good in such material; the very best leather for this purpose is to be had from some shoe factory. Get the scraps left after soles are punched; this scrap is heavy, and furnishes a satisfactory material. Fill a hardening box with the scrap; put on the cover and seal. The box is then placed in the furnace and the leather charred in the same manner as when charring bone. Care must be taken not to overdo it; it should be charred just enough to pound up well.

The granulated charcoal referred to may be obtained by pounding common hardwood charcoal. The most satisfactory charcoal, however, is to be obtained in the market, because the kernels are all of one size, and when the cost of pounding is taken into consideration the commercial article is the cheaper.

* * *

The *Electrical Review* (London) says that a piece of old blueprint paper can be used to determine the positive and negative poles of an electric wire. All that is necessary is to moisten the paper and apply it to the terminals of which it is desired to determine the polarity. In a few seconds the blue paper will be bleached in the vicinity of the negative terminal.

Census Bulletin No. 247, "Power Employed in Manufactures," states that the aggregate power employed in manufacturing establishments of the United States during 1900, was 11,300,081 H.P.; in 1890 it was 5,954,655 H.P.; in 1880, 3,410,-837 H.P.; and 2,346,142 H.P. in 1870. Of the total power used in 1900, steam engines furnished 8,742,416 H.P.; water wheels, 1,727,258 H.P.; electric motors, 311,016 H.P.; gasoline engines, 143,850 H.P.; and other sources, 54,490 H.P.

LETTERS UPON PRACTICAL SUBJECTS.

A HANDY CENTERING TOOL.

Editor MACHINERY:

The little tool shown in Fig. 1, which I call a centering scale, has been found very handy for locating the centers in the ends of a piece of work. It is cut from sheet steel about 1-32-inch in thickness, and no great accuracy is required in its construction. It may be marked out with a scratch awl and then filed down to the lines. The heights of the different steps are but one-half of the numbers which are stamped upon them, the numbers being simply to indicate the diameter of the stock for which each respective step is used. The steps, therefore, rise but 1-16-inch and are about ½-inch wide.

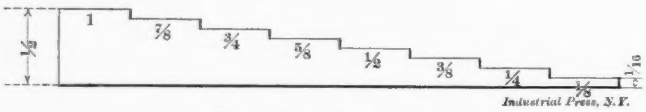
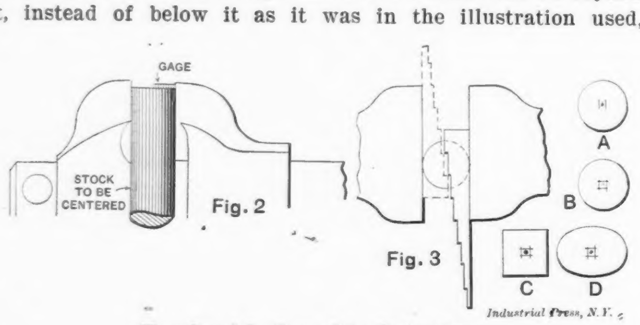


Fig. 1. The Center Gage.

The method of using the gage is shown in Figs. 2 and 3. The stock to be centered is put in a vise so that the jaws project about ¼-inch above the top of the work. The gage is laid upon the work with the long side resting against one of the vise jaws. Having selected the step which appears to be nearest to the center of the stock, a line is scribed upon the stock, using the edge of this step as a guide. The gage is then turned around with the long edge resting against the other vise jaw, as shown by the dotted lines in the same figure, and another line is scribed upon the stock, guided by the same step that was used before. We now have two parallel lines scribed upon the stock as shown at *A*, Fig. 3, and if the step which was nearest to the center has been used these lines cannot be over 1-16-inch apart. It will sometimes happen that the step nearest the center will be beyond it, instead of below it as it was in the illustration used,



Figs. 2 and 3. Uses of the Center Gage.

so that the scale, when placed in position for drawing the second line, will overlap the first line drawn but the result will be the same. When these two lines have been drawn the work is turned around one-quarter of a revolution and two more lines are drawn in the same manner, thus forming a square as shown at *B*. As this square is never over 1-16-inch, its center, and consequently the center of the stock, is readily located by the eye. *C* and *D*, in the same figure show the application of the gage to centering square and oval stock.

B. W. FRANK.

LARGE VS. SMALL UNITS.

Editor MACHINERY:

In a recent issue of your journal one of your correspondents was making quite a rational objection about measurements of some importance being taken in inches instead of feet and yards. I think he is quite right, but I should say the same objection can be raised against heavy weights taken in pounds instead of tons. Most of the time a steam engine, a fly-wheel or a dynamo are estimated in so many thousand pounds while the same weights expressed in tons of 2,000 pounds would certainly bring a clearer idea of the statement to the mind of the reader.

To say, for instance, that a piece of machinery is weighing 500,000 pounds is just like expressing the distance from New York to Chicago in yards or feet instead of miles. In the case referred to, it would indeed be just as intelligible, if not more, to say that the machine weighs two hundred fifty tons (250 T) besides being quicker to spell and write.

An objection of the same kind can be extended to electrical measurements. In these days of long distance transmissions at high tension, it is quite common to hear about electric currents of 30, 40 or 60,000 volts. Why not say 30, 40, 50 "kilovolts." The prefix KILO means one thousand, just as the word "kilowatt" stands for 1,000 watts; it would be only a matter of a very short time to get used to the new unit, which in the end has nothing in itself so very strange as to prevent its adoption. As for the tons instead of pounds it is only a matter of convention.

EDW. C. CHODZKO.

Haiphong-Tonkin, China.

A SPECIAL TURRET LATHE TOOL.

Editor MACHINERY:

A short time ago we were making the pieces shown in Fig. 1, which are of brass and go on the ends of water filters. These pieces were tapped at *A*, while at *B* they were counterbored, as shown, to allow the insertion of a wire screen disk and a felt washer. The work was done on a turret lathe and the principal problem was to design a tool that would

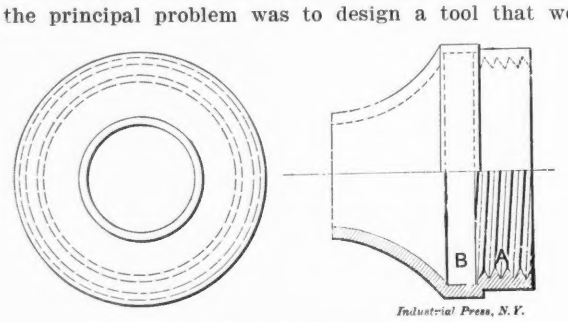


Fig. 1. One of the Pieces to be Machined.

cut the recess *B*. Fig. 2 shows the tool that we made for this purpose. *C* is the body of the tool which was grooved to hold the four cutters *D D*. These were turned and ground to the proper diameter for boring the hole to tapping size. The check collars were threaded on the back end to take the thrust of the cutters. A hole was drilled for the shank of the circular cutter F and the back end of this was fitted with the handling lever *G*. The circular cutter was cut away as shown so that when the lever was in its normal position, lying against the shank, the cutting edge cleared the work. In operation the tool was run in to the casting until it reached a stop. The lever *G* was then raised until the cutter ceased

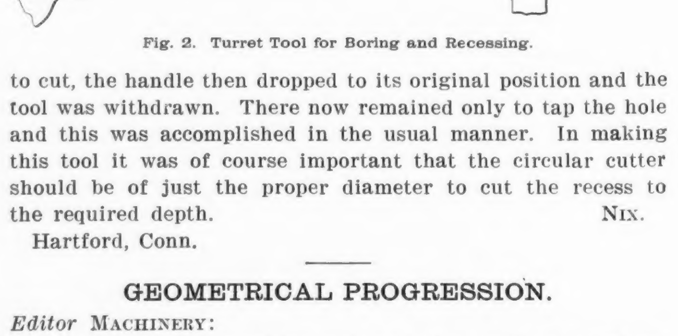


Fig. 2. Turret Tool for Boring and Recessing.

to cut, the handle then dropped to its original position and the tool was withdrawn. There now remained only to tap the hole and this was accomplished in the usual manner. In making this tool it was of course important that the circular cutter should be of just the proper diameter to cut the recess to the required depth.

NIX.

Hartford, Conn.

GEOMETRICAL PROGRESSION.

Editor MACHINERY:

In designing such machine tools as lathes, milling machines, boring mills, etc., it is customary to arrange the speeds and feeds in geometrical progression, that is, each successive feed

or speed is increased by the same multiplier at each step, as: 1, 2, 4, 8, or 3, 9, 27, etc. The common multiplier is called the ratio. For any one designing tools in this way the accompanying table may be of value, particularly to those who are unfamiliar with the use of logarithms. The table explains itself, yet may be made clearer by a few examples.

TABLE OF GEOMETRICAL PROGRESSION.

Ratio.	Increase in per cent.	NUMBER OF SPINDLE SPEED OR FEED FROM SLOWEST TO FASTEST.																							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1.10	10	1	1.10	1.21	1.33	1.46	1.61	1.77	1.95	2 14	2.36	2.59	2.85	3.14	3.45	3.80	4.18	4.60	5.05	5.56	6.11	6.73	7.40	8.14	8.95
1.15	15	1	1.15	1.32	1 52	1.75	2.01	2.31	2 66	3.06	3.52	4.05	4.65	5.35	6.15	7.08	8.14	9.36	10 76	12.38	14.23	16.37	18.82	21.65	24.89
1.20	20	1	1.20	1.44	1.73	2.07	2.49	2.99	3.58	4.30	5.16	6.19	7.43	8.92	10.70	12.84	15.41	18.49	22.19	26.62	31.95	38.54	46.01	55.21	66.25
1.25	25	1	1.25	1.56	1 95	2.44	3.05	3.81	4.77	5.96	7.45	9.31	11 64	14.55	18.19	22.74	28.42	35.53	44.41	55.51	69.39	86.74	108.40	....	....
1 30	30	1	1.30	1.69	2.20	2.86	3.71	4.83	6.27	8.16	10.61	13.79	17.92	23.30	30.29	39.37	51.19	66.54	86.50	112.50	....	....	....	....	....
1.35	35	1	1.35	1.82	2.46	3.32	4.48	6.05	8.17	11.03	14.88	20.09	27.14	36.64	49.47	66.78	90 37	121.70	....	....	....	....	....	....	....
1.40	40	1	1.40	1.96	2.74	3.84	5.38	7.53	10.54	14.76	20.66	28.93	40.50	56.69	79.37	111.10	....	....	....	....	....	....	....	....	....
1.45	45	1	1.45	2.10	3.05	4.42	6.41	9.29	13.48	19.54	28.33	41.09	59.57	86.38	125.30	....	....	....	....	....	....	....	....	....	....
1.50	50	1	1.50	2.25	3 38	5.06	7.59	11 39	17.09	25.63	38.44	57.67	86.50	129.80	....	....	....	....	....	....	....	....	....	....	....
1.55	55	1	1.55	2.40	3.72	5.77	8.95	13.87	21.49	33.32	51.64	80.04	124.10	....	....	....	....	....	....	....	....	....	....	....	....
1.60	60	1	1.60	2.56	4.10	6.55	10.49	16 78	26.84	42.95	68.72	110.0	....	....	....	....	....	....	....	....	....	....	....	....	....
1.65	65	1	1.65	2.72	4.49	7.41	12.23	20.18	33.30	54.94	90.65	149.6	....	....	....	....	....	....	....	....	....	....	....	....	....
1.70	70	1	1.70	2.89	4.91	8.35	14.20	24.14	41.03	69.75	118.60	....	....	....	....	....	....	....	....	....	....	....	....	....	....
1.75	75	1	1.75	3.06	5.36	9.38	16.41	28.72	50.27	87.96	153.90	....	....	....	....	....	....	....	....	....	....	....	....	....	....
1.80	80	1	1.80	3.24	5.83	10.50	18.90	34 01	61.22	110.20	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
1.85	85	1	1.85	3.42	6.33	11.71	21.67	40.09	74.17	137.20	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
1.90	90	1	1.90	3.61	6.86	13.03	24.76	47.05	89.39	169.80	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
1.95	95	1	1.95	3.80	7.41	14.46	28.20	54.98	107.2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
2.00	100	1	2.00	4.00	8.00	16 00	32.00	64.00	128.0	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

Suppose we have a four-stepped cone and wish to make the entire ratio about 4 to 1. We find in the fourth column of the table a value of 4.10. The ratio between two adjoining speeds is given as being 1.6. The back-gear ratio in this instance should be 6.55.

Suppose now that we want 16 feeds, the fastest to be 28 times the slowest. The ratio between two adjoining feeds should then be 1.25, or an increase of 25 per cent.

D. AG. ENGSTROM.

DISCUSSING THE METRIC SYSTEM.

Editor MACHINERY:

The recent discussion before the A. S. M. E. of the pros and cons of the metric system brought to light a considerable amount of information on the subject. One phase of the discussion dealt with the value of the metric system to machine tool builders who may desire to extend the export trade in their products. It was pointed out that by adopting the metric system of measures and applying them in the construction of his product, the machine tool builder would take one important step toward meeting the requirements of his foreign customers and would be benefited accordingly. On the other hand it was contended that by far the greater part of the machinery sold abroad was of standard construction, proving that a change in our system of measures is not called for.

CONVERSION OF SCREW THREADS FROM ENGLISH TO METRIC.

Lead Screw Four Threads per Inch.

Threads per inch.	Stud.	Screw.	PITCH OF THREAD IN MILLIMETERS. COMPOUND GEARS USED.		
			20/127	40/127	80/127
1	96	24	4.000	8.000	16.000
2	48	24	2 000	4.000	8.000
3	36	27	1.333	2.666	5.333
4	48	48	1.000	2.000	4.000
5	48	60	.800	1.600	3.200
6	48	72	.666	1.333	2.666
7	48	84	.571	1.142	2.284
8	48	96	.500	1.000	2.000
9	48	108	.444	.888	1.777
10	24	60	.400	.800	1.600
12	24	72	.333	.666	1.333
14	24	84	.285	.571	1.142
16	24	96	.250	.500	1.000
18	24	108	.222	.444	.888

It is, of course, true that whether a machine was made after a drawing dimensioned in English measure or metric measure makes very little difference to the man who is using it. Feed screws, and lead screws, however, require a modification of the above statement. Since the work of these screws bears a fixed relation to the system of measures to which they were made, to make them available for a different system of measurement we must have a translating device. The process is analogous to expressing a thought in different languages. It is this process of translating the two systems of measures, and the facility of its accomplishment with most classes of machine tools that it is desired to illustrate here.

To begin with, let us look up a metric conversion table. One of the prominent figures on any such table is 25.4. Twenty-five and four-tenths millimeters equals one inch. To cut a metric screw on an ordinary lathe of American make obviously requires at least one gear, the number of teeth in which is divisible by 25.4. A gear of 127 teeth is the smallest that will answer our requirements, and this same gear is, as will be seen, the key to the whole situation.

Now to take a practical example, suppose that we have an American lathe whose lead screw has four threads per inch, and that we wish to cut a thread whose pitch is one millimeter. We know that with the spindle and the lead screw revolving at the same rate four revolutions of the spindle will advance the tool carriage one inch or 25.4 millimeters. One revolution will advance the carriage $\frac{25.4}{4} = 6.35$ millimeters. It is clear that in order to secure a carriage travel of one millimeter for every revolution of the spindle, the latter must revolve 6.35 times as fast as the lead screw. In other words, we must use two gears whose ratio is 1 : 6.35. But dividing 127 by 6.35 gives 20 exactly. So that to cut the

required thread we need but mount our 20 gear on the stud, the 127 gear on the lead screw and the transformation is effected.

Furthermore, if we use the two gears 20 and 127 as compounding gears on the studplate, thereby leaving the stud and the lead screw free for the use of the ordinary change gears, the lathe becomes, for all practical purposes, a lathe with a metric lead screw. How this is accomplished is, perhaps, more plainly shown by the table on the preceding page.

The same method applied to lathes with lead screws of 5, 6, 7, and 8 threads per inch will give us 25-127, 30-127, 35-127, and 40-127 respectively as translating gears to be used in the same manner to get similar results.

Now let us turn to the milling machines in general. The graduated disks on the ends of the feed screw are familiar to us all. They are usually made to read in thousandths of an inch. To convert any English feed screw into a metric screw, with divisions reading in millimeters or fractions thereof it is but necessary to use a disk divided into 127 equal parts. A little arithmetic will show that one division of such a disk when used in connection with a feed screw of three threads per inch, will represent a movement of the slide equal to .066 (sixty-six thousandths) millimeters; when used in connection with a screw of four threads per inch it shows a movement of .05 (five hundredths) millimeters; and when used with a screw of five threads per inch it indicates .04 (four hundredths) and so on.

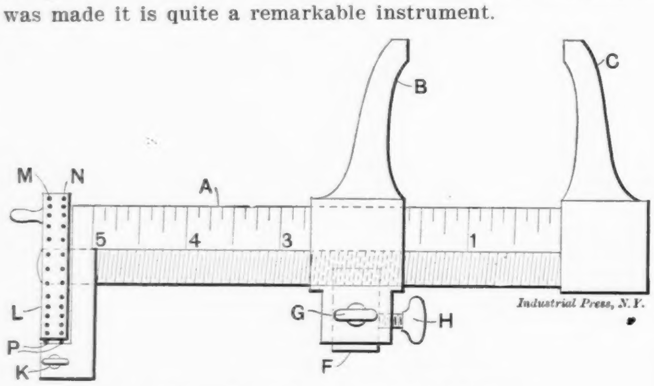
Why, under the circumstances, the foreign buyer should risk the delay and the additional expense connected with extras (such as furnishing metric screws is apt to incur) does not seem clear. Nor can the present system of measures, in the light of the foregoing, be considered as a serious handicap to the further development of our export trade in machine tools. JOHN M. BARNAY.

Cincinnati, Ohio.

AN ANCIENT MICROMETER.

Editor MACHINERY:

The accompanying sketch shows what I believe to be the oldest micrometer in existence. It was made by Henry Frost in Portland, Maine, over fifty years ago, and its accuracy compares favorably with the more modern micrometers. Considering the crudeness of the tools with which this micrometer was made it is quite a remarkable instrument.



Micrometer made over Fifty Years ago.

It consists of a bar, *A*, ½ inch square, with a fixed jaw *C* and a movable jaw *B*. Under the bar is a ⅜-inch screw having sixteen threads per inch. The movable jaw is provided with the half nut F which is thrown in and out of mesh with the screw by means of the thumb screw *G* and securely locked in either position by the screw *H*. The beam being graduated in eighths it is only necessary to set the movable jaw upon the eighth mark nearest the desired measurement and then revolve the wheel *L* in order to obtain the fine adjustment. The face of this wheel has two rows of holes, *M* and *N*, and below will be seen two pins, *P*, which are so arranged that when the thumb screw *K* is moved to the right one of them engages the outer row of holes, and when it is moved to the left the other pin engages the inner row of holes. As the row *M* contains 40 holes, a movement from one hole to another will cause a movement of the sliding jaw of about .0015 inch, or a movement of ten holes will move the jaw exactly 1-64 inch, and a full revolution 1-16 inch. The inner row contains 21 holes so that the movement between two holes advances the jaw 1-336 inch, or a revolution of 7 holes would produce a movement of 1-48 inch, 14 holes would produce a movement of 1-24 inch, 28 holes 1-12, etc.; 1-3 inch would be obtained by revolving the wheel 112 holes. These fractional divisions are employed but little at present for fine measurements, but perhaps they were used more frequently in the early 50's. H. K. G.

Portland, Me.

EQUIVALENTS OF THE METER

Editor MACHINERY:

The following is a list of measures of length which are used in Germany and its borders. You will notice by this what a mix-up there is yet, after the adoption and use of the metric system for twenty-five years.

In all the states, with the meter, you will find the old standards still in use.

This table gives nearly the equivalent number, in inches, required to make a meter:

London	$39\frac{3}{8}$	inches	= 1	meter.
Rheinland	$38\frac{7}{32}$	"	"	"
Hamburg	$41\frac{15}{16}$	"	"	"
Wien (Vienna)	$37\frac{11}{32}$	"	"	"
Sachsen (Saxon)	$42\frac{3}{8}$	"	"	"
Braunschweig	$42\frac{3}{32}$	"	"	"
Bayern (Bavaria)	$41\frac{3}{24}$	"	"	"
Paris	$36\frac{23}{24}$	"	"	"
Hannover	$41\frac{1}{8}$	"	"	"

Newbrandenburg, Germany. A. J. D.

HARDENING AND TEMPERING A DIE—A CRITICISM.

Editor MACHINERY:

I was very much interested in Mr. F. E. Shailor's article on forming dies and the use of rubber in connection with them, and I must confess that I have been benefited by the same as well, as the use of rubber as a forming base was quite new to me. It appears to me, however, that some of the points advocated by him in making the dies are, to say the very least, open for discussion. Mr. Shailor states, that the die after immersing in the bath should be held in one place, in order to prevent its warping. It has always been my experience that a die, especially if it be heavy, does not attain that degree of hardness when held in one place that it does when constantly moved about. The reason for this is obvious, because the water surrounding the die becomes heated and does not chill the surface to any great extent. If, on the other hand, the position of the die is gently but constantly changed, the water in the immediate neighborhood is always cold, thus causing a deep chill. As the correspondent's main object in view seems to be the prevention of warping, I am inclined to believe that his trouble lies not as much in the immersing as in the uneven heating of the die. I had a number of gang dies given to me some years ago, the dimensions of which were ½-inch × 2½ × 9 inches and by heating them in a muffler furnace and immersing diagonally across the corners I had no difficulty in keeping them straight. It is hardly necessary to state that the die should not be moved about broadside to the water, but with the point of the least resistance.

Mr. Shailor's method of drawing the temper of the die also seems to me to be a strange one. The method which I have found to be the safest is the placing of the die over a Bunsen burner on a stiff piece of sheet iron. The idea of drawing the temper and the reason for it is the gradual reduction of the brittleness through the entire die, starting at the base and traveling upward toward the point of application, which in a blanking die is the cutting edge, and in a forming die the forming surface. If, therefore, the forming die in question is placed on hot coals or near the fire, the heat can attack the frail portion of the die and draw the temper out of it before even the strain in the die is relieved, which may result in cracks running along the sharp edge of the thread in the form.

I cannot join my brother toolmaker in his objection to the use of oily waste while drawing the temper and I still cling

to the time-honored custom. This may be a matter of training or opinion, or both; but I am convinced that the color on the die after wiping with oily waste is the true color and the color unwiped the false. I have noticed that a piece of steel during the drawing process does not show any color for some time if untouched and then changes color very rapidly, while an occasional touch with an oily substance shows the changes of the various degrees very plainly.

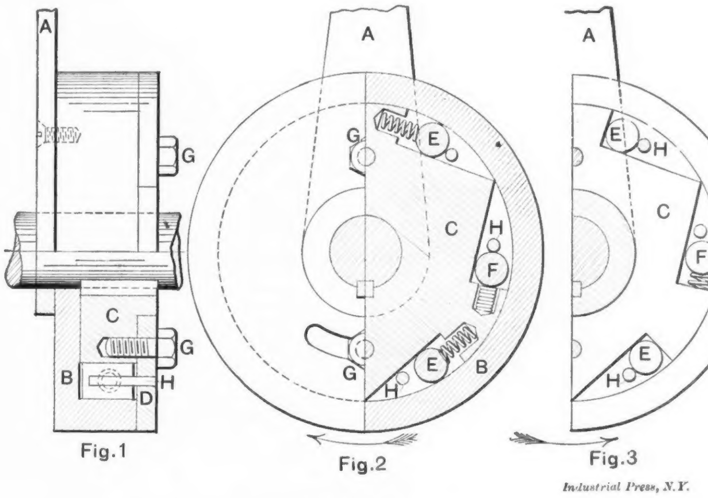
To close my criticism of Mr. Shailor's methods I would like to warn against the overdoing of the practice of trying a forming die with sharp corners while soft, as I nearly spoiled a die at one time by doing this. FRANK GREINER.

New York, N. Y.

A REVERSIBLE FRICTION RATCHET.

Editor MACHINERY:

In constructing a large single-acting press, a short time ago, we were called upon to furnish a roller feed that would be reversible so that stock could be fed either from or toward the operator. The ratchet by which this was accomplished was not of new design, as it has been used on some presses for many years to my knowledge, but I have never seen it described. Its simplicity and the ease with which it can be reversed recommend it for many places in machine tool construction where a noiseless reversible ratchet feed is required. The ratchet is mounted on one of the feed roll shafts and is operated in the usual way from a crank on the main shaft of



Reversible Friction Ratchet.

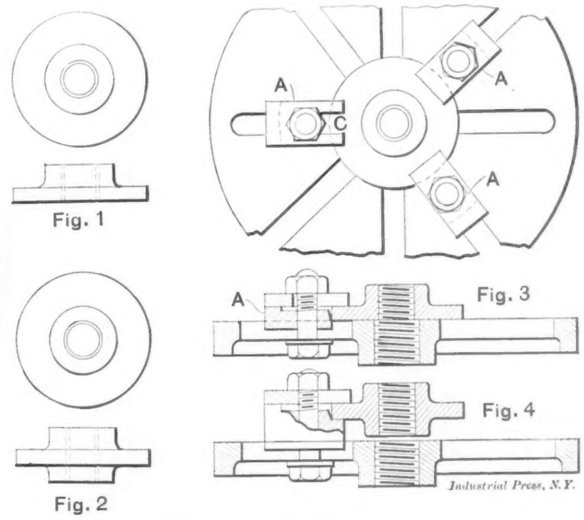
the press. The connecting rod from this crank is connected with the upper end of the ratchet arm *A*. This arm is fastened to the ratchet casing *B* and imparts to it its oscillating motion. This motion is transmitted to the roll shaft by a set of friction rolls and the hardened steel block *C*, to which the shaft is keyed. As the casing is oscillated in one direction or the other one set of the steel rollers, *E*, *E* or *F*, *F*, becomes bound between the block and the casing and causes them to revolve together. As soon as the direction of rotation of the casing is reversed the rolls are freed from their contact and the casing is moved backward independent of the block. As will be seen by the sketches, one set of the rollers only is employed when feeding in a given direction. In order to hold the other set inoperative a cover plate *D* is placed over the face of the ratchet block and fastened to it by two bolts, *G*, *G*. At the points where these bolts pass through the plate are two grooves which allow the plate to turn around the shaft through an angle of about 20 degrees. This plate is fitted with six retaining pins *H*, *H*, *H*. When the plate is moved so that the bolts are at one side of the slot these pins hold one set of rollers out of action as shown, in Fig. 2, where rollers *E*, *E* are free to move the block and the set *F*, *F* are held out of action. In this position the ratchet will feed the roll-shaft in the direction indicated by the arrow. Wishing to reverse the direction of rotation of the shaft, it is only necessary to loosen the bolts *G*, *G*, and turn the cover plate as far as the slots will allow. This causes the retaining pins to throw the set of rolls *E*, *E* out of action and to release the set *F*, *F* as illustrated in Fig. 3. The shaft is then rotated in the opposite direction. The springs shown back of the rolls insure the active set being always in contact with the casing so that there is practically no lost motion.

New York, N. Y. GEORGE HENRY.

CENTERING WORK ON THE FACEPLATE.

Editor MACHINERY:

Most mechanics appreciate the difficulty of turning pieces true with a tapped hole by using a threaded arbor. Owing to this difficulty we have often to resort to other expedients. We had a large number of castings, such as are shown in Fig. 1, which were finished all over, and it was necessary that the thread be true with the exterior surface and at right angles with the face. Not having a jaw chuck in the shop that was accurate enough for this purpose, we proceeded to machine them in the following manner: The castings were first drilled to the tapping size and were accurately turned upon a common arbor in the usual way. We then bolted to the faceplate the three blocks, *A*, *A*, *A*, which were so located that they could be bored out to the diameter of the flange on the casting. These were bored slightly tapering so that the finished piece could be easily removed. Three clamps were fitted to these blocks and one of them was slotted as shown at *C* so that it could be withdrawn under the bolt head and the casting removed and replaced without taking out the other



Faceplate Centering Pieces.

two bolts. The holes in the castings were screw-cut as nearly to size as possible and then completed with a sizing tap, which was supported upon the tailstock center.

Occasionally the castings had a hub on both sides, as shown in Fig. 2, and in this case the locating pieces were made with a shoulder as is illustrated in Fig. 4. FRANCIS W. SHAW.

Birmingham, England.

TESTS WITH FLAKE GRAPHITE.

Editor MACHINERY:

We have read with much interest your editorial in MACHINERY for December on the subject of "Graphite vs. Friction," and we have thought that you might be pleased to receive a contribution on this subject, especially as this will cover a test made by Professor W. F. M. Goss, of Purdue University.

The experiment consisted in an attempt to wear down brasses by the use of dry graphite alone as a lubricant. The experiment was made in connection with a special testing machine and the manner of applying the graphite was so arranged that the journal was made to revolve in a bath of graphite. The journal was fresh from the lathe where it had been well turned and slightly polished. The brasses were smooth-bored and quite free from imperfection. Judged by the standard of a railroad shop, both the journal and brasses were "ready to run."

With a new journal and brass, it would be expected that if run in oil, they would at first heat more or less and that

some time would be required to work the brass down to a perfect fit on the journal. The outline of the test provided that no oil should be used but that an attempt be made to wear the brass down by use of dry flake graphite alone. Therefore no oil was used at any time during the test. In carrying out the experiment, as much pressure was put on the brasses as the machine would carry and the journal was run as fast as was practicable without too much heating and continued as long as the belt would carry the load. The running was attended with a great deal of noise, the squeak being similar to that which proceeds from a dry axle-box. The results showed that the frictional resistance was at all times very high; values of 16 per cent. or more being characteristic of unlubricated surfaces, as, for example, of a brake-shoe upon a car-wheel. As the tests proceeded, the frictional action improved; the values in coefficients gradually declining.

The tests were very interesting and we only regret that space will not permit us to furnish your readers with a full summary of results. We will only say that when the machine was taken apart and the bearing surfaces carefully examined, the journal was found to be without a scratch and to have a high polish. The upper brass was found to have about 35 per cent. of its surface in bearing. A close examination of the brass revealed the fact that the surface of contact had not been secured as a result of wear in the brass as is usually the case, but that graphite had implanted itself in the surface of the metal and where the surface of the brass was more remote from that of the journal and had built up, as it were, a graphite-bearing surface. This built-up surface possesses a bright, metallic lustre, is well burnished and while compacted as by heavy pressure and quite capable of easily supporting a heavy load, it would flake off under the action of a tool; the flakes retaining the shape of the bearing after removal. When the brass was in actual contact with the journal, it was but little worn.

In another test, when the machine was opened, the bearing space amounted to altogether 45 per cent. of the area of the brass and was composed almost entirely of an overlaying mass of compact graphite, leaving the entire central portion of the brass out of bearing. Within this central portion there was more or less graphite but much of it was imperfectly compacted and it fell away when the brass was removed. Parts of its surface were bright and gave evidence of having at some time had contact with the journal, but just previous to its removal it did not have contact.

The conclusion to be drawn from the set of experiments is a two-fold one. The first is that the brass cannot be worn to a fit on its journal while lubricated by graphite alone. Not only does the graphite tend to fill in the brass where it does not touch the journal, but it acually builds up a new shell within the brass and by so doing relieves the brass itself from much of the contact which it would otherwise have.

The second fact developed is to the effect that neither journal nor brass is easily cut or injured in the presence of flake graphite. The tests showed that with no other lubrication than dry flake graphite, the journal and brass might be run together for hours at a time, keeping up to a high temperature, and that this might be done repeatedly and yet the rubbing surfaces of the bearing remain unscored.

Joseph Dixon Crucible Co.
Jersey City, N. J. Per Secretary.

ATTACHMENT FOR RELIEVING FORMED CUTTERS.

Editor Machinery:

In making formed face-cutters, such as are used in the screw machine to operate on the end of the bar, it is desirable to so shape the cutting teeth that they can be ground without changing their form. To accomplish this I have employed the relieving attachment here illustrated, which has given very good satisfaction and has the advantages of being simple in construction and easily applied to any style of lathe. As it is operated by the change gears of the lathe it can easily be geared up to relieve cutters having any number of teeth. The lathe to which it is attached should be of rigid design and fitted with a compound rest. The screw cutting gears should not be finer than 14 diametral pitch. The details of this attachment as applied to the lathe will be clearly seen by referring to Fig. 1. The bracket *A* is bolted onto the side of the headstock and carries the cam shaft *D*. The other end of this shaft is carried in the bracket *B* which slides along one of the ways of the lathe and is provided with a clamping device by means of which it can be fastened at any desired position along the lathe bed. The shaft in this bearing is $1\frac{1}{4}$ inch in diameter while for the remainder of its length, except in the thrust collars, it is 1 inch in diameter. This shaft is splined from the bearing *A* to its outer end and is cut about 18 inches longer than is necessary when it occupies the position shown in the figure, which makes allowance for moving the bearing *B*.

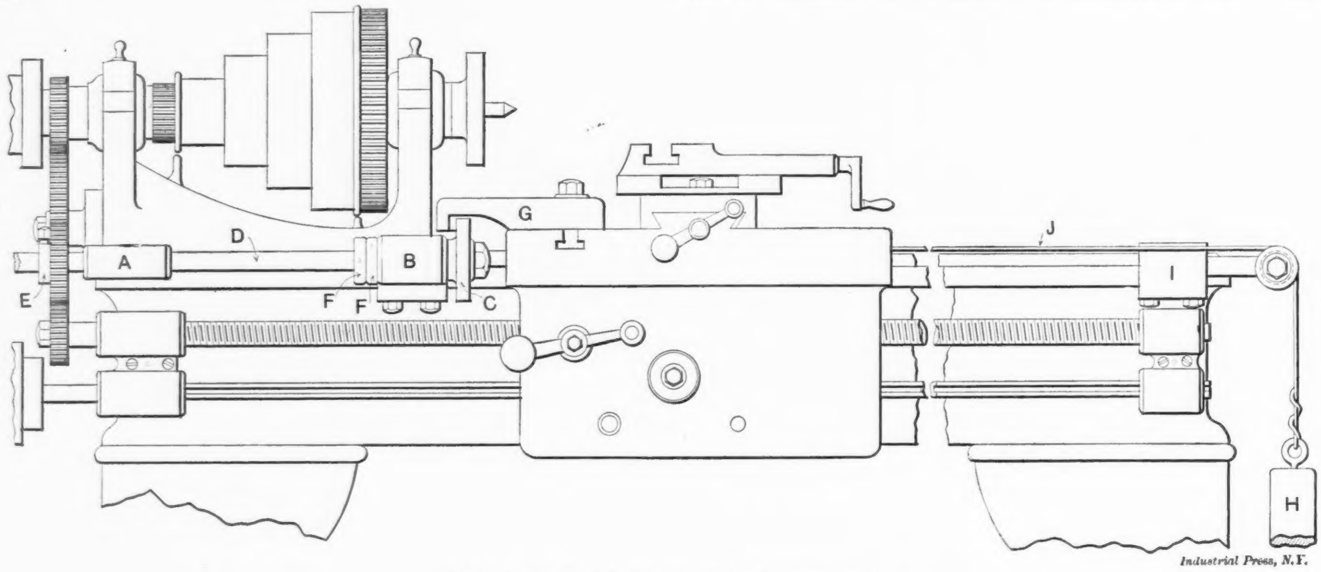


Fig. 1. Lathe arranged for Relieving Face-cutters.

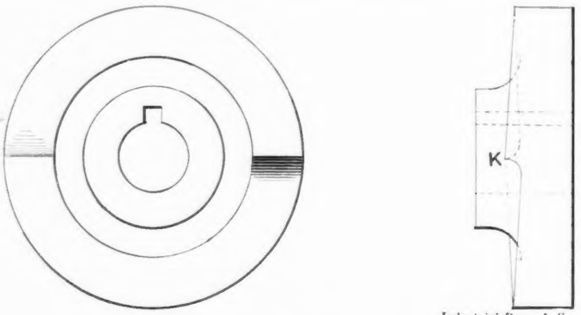


Fig. 2 Two-step Cam for use in Relieving Face-cutters.

The gear *E* is made of such a diameter as to mesh with

the gear on the lead screw and these two gears are always employed when using this attachment. The hub of this gear gives it more bearing surface on the cam shaft; a key is fitted to slide with it along this shaft while the setscrew holds it in position when the cam has been set.

Upon the inner end of the cam shaft is placed the face cam *C* which serves to impart the backward and forward motion to the lathe carriage. In making this attachment it is best to provide three of these cams having one, two, and three steps respectively, as cutters having any number of teeth can then be backed off with much simpler combinations of change gears than when but one of the cams is provided. A detail of one of these cams, one having two steps, is shown in Fig. 2. They are made of tool steel, hardened, with a ⅞-inch hole and a key-way to fit the end of the shaft *D*. When no cam cutter is at hand I have found the best way to make them is to mill—with a 5-16 inch convex cutter—one, two or three, as the case may be, radial slots in the face of the cam. Then gear up the lathe to the required pitch and work the stock off by hand. The cam finger *G* is securely fastened to the lathe carriage and its point is always in

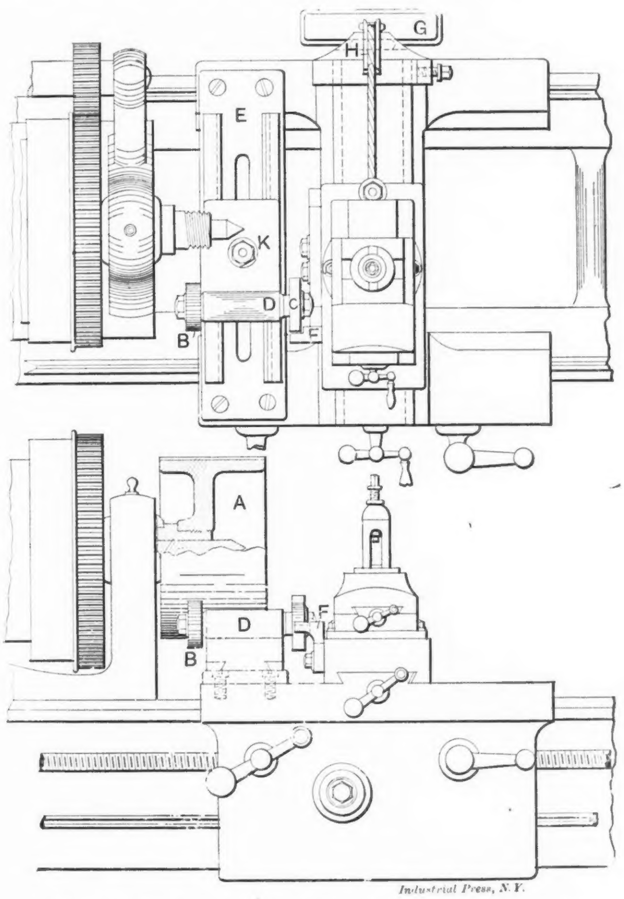


Fig. 3. Lathe arranged for relieving Formed Milling Cutters.

contact with the face of the cam so that as the cam revolves it pulls the lathe carriage forward until the finger reaches the top of the step *K* when it is drawn back by the action of the weight *H* which is attached to the carriage by the wire *J*. In pulling the carriage forward the thrust of the cam is taken up by the two thrust washers *F F* which are fitted to the cam shaft by a 1 ¼-inch fine thread.

The lathe with which this attachment is used is so constructed that all of the gears in the apron can be released, leaving the carriage at liberty to oscillate freely; should it be placed on a lathe that was not so constructed it would be well to remove the screws binding the carriage to the apron and thus allow the carriage to move entirely independently. The face cutter being relieved is held in a split collet in the spindle of the lathe or strapped against the head center and held in a steady rest. The forming tool is fed forward in the compound rest which is set at right angles with the cross-slide.

For relieving formed milling cutters, worm wheel hobs, etc., I have made use of the arrangement shown in Fig. 3. This is applicable to any good rigid lathe that has a compound rest and is so constructed that the cross-slide screw can be disconnected from the carriage. A lathe having a taper attachment is usually admirably adapted for this purpose, as it is usually arranged so that the cross feed screw is disconnected by simply releasing a nut or two. The cast iron gear *A* screws onto the spindle of the lathe and is cut the same pitch as the change gears so that these gears may be used in gearing the attachment to relieve cutters having any number of teeth. The gear that I used for this purpose was 10 inches pitch diameter of 14 diametral pitch, having 140 teeth. It is shown in detail in Fig. 4. Through the web of this gear is cut an elongated slot for the insertion of the tail of the driving dog, while a sliding clamp is used to prevent back lash. One end of the shaft which is carried in bearing *D*, Fig. 3, is made exactly like the end of the lead screw of the lathe so that any of the change gears can be used for the gear *B*. On the other end of this shaft is the hardened tool steel cam *C* which imparts the oscillating motion to the carriage. Should the lathe not have a very great assortment of change gears it would be well to provide several of these cams having one, two, three, and four steps, respectively, so that cutters having any number of teeth can be relieved. The bearing *D* carrying the crank shaft is dovetailed to a cross slide *E* which, in turn, is bolted to the lathe carriage. This allows the bearing to be moved in or out to accommodate the different sizes of change gears that may be used for the gear *B*, while a bolt *K*, working in a slot through *E*, serves to clamp *D* firmly when it has been placed in position. Fastened to the cross slide carriage is the cam finger *F* which transmits the motion of the cam to the

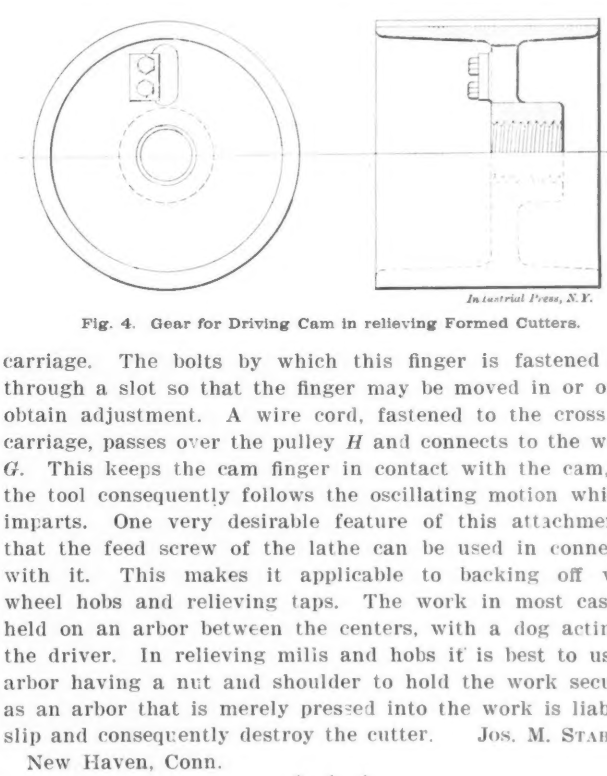


Fig. 4. Gear for Driving Cam in relieving Formed Cutters.

carriage. The bolts by which this finger is fastened pass through a slot so that the finger may be moved in or out to obtain adjustment. A wire cord, fastened to the cross slide carriage, passes over the pulley *H* and connects to the weight *G*. This keeps the cam finger in contact with the cam, and the tool consequently follows the oscillating motion which it imparts. One very desirable feature of this attachment is that the feed screw of the lathe can be used in connection with it. This makes it applicable to backing off worm wheel hobs and relieving taps. The work in most cases is held on an arbor between the centers, with a dog acting as the driver. In relieving mills and hobs it is best to use an arbor having a nut and shoulder to hold the work securely, as an arbor that is merely pressed into the work is liable to slip and consequently destroy the cutter. Jos. M. Stabel.

New Haven, Conn.

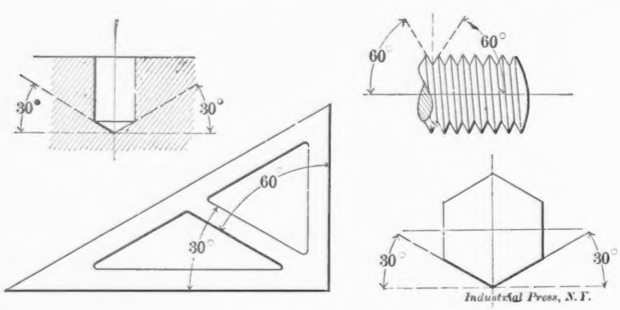
* * *

M. Quesnel, a French engineer, is alleged to have discovered alloys for aluminum that impart to this widely advertised metal most astonishing qualities. By varying the amount of his alloy from one part in 12 to one part in 240 he obtains aluminum compounds varying in tensile strength from 29,000 to 58,000 pounds per square inch. These have different characteristics so that some may be chased, soldered, brazed, forged, rolled into plates and leaves or drawn into wire, depending on the amount of alloy. It can be made soft like pure aluminum or stiff and rigid like steel and possessed of nearly the same strength and weighing only about one-third as much. So much has been promised for aluminum and its alloys that we shall await the advent of this new wonder with some distrust until its claims to recognition are based on actual demonstration.

CONTRIBUTED NOTES AND SHOP KINKS.

A HANDY TRIANGLE.

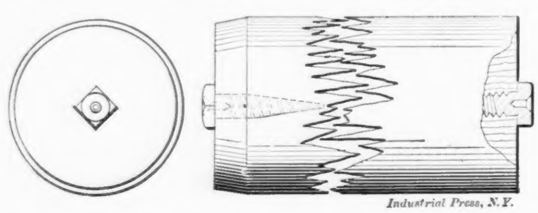
A. T. S. sends us the sketch of a triangle that he made for his own use and found to be a very handy tool. It is a 30 by 60 degree triangle, having internal angles of the same degrees, but opposite to the external ones. With a triangle



of this form hexagons, screw heads, the bottom of drilled holes, etc. can be easily and quickly drawn, as it is not necessary to reverse or turn over the triangle, but merely slide it along. Every draftsman doing detail work would find this tool a valuable acquisition to his kit.

A SPECIAL ARBOR.

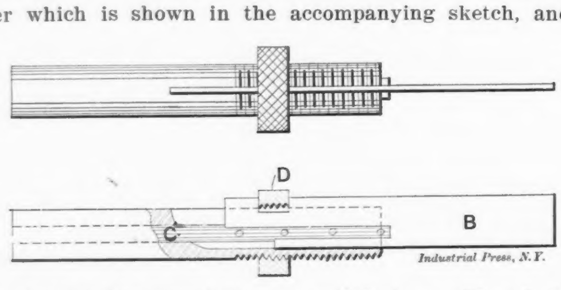
Regarding special arbors, D. M. says: When a job requires a special arbor, of from 3 to 6 inches in diameter, it is quite customary to drive two cast iron collars onto a smaller arbor, placing them at the proper distance to accommodate the particular job in hand. These collars are then turned to fit the pieces with which they are to be used. As a handier scheme than this I have used a wooden arbor very



successfully when the turning was not very heavy. This is made of hard wood with very little, if any, taper except for about half an inch at the end where it first enters the hole. A ¾-inch lag or coach screw is screwed into each end of the block and these are centered in the drill press. The block is then turned to size on the centers. This arbor should be used very soon after turning, before the wood has time to shrink.

AN ADJUSTABLE FINGER FOR USE ON THE GRINDER.

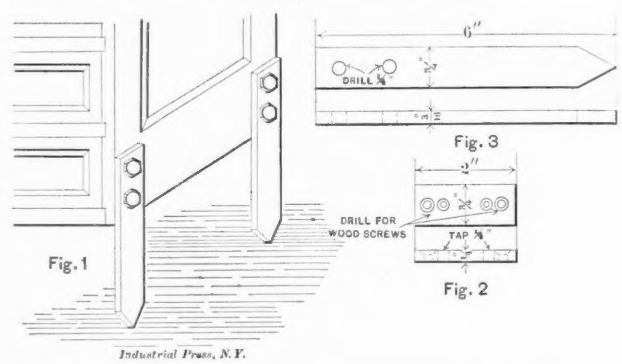
Most any one who has run a grinder to any extent has noticed the lack of fine adjustment on the stop finger when backing off or grinding the lands of reamers and cutters. With the ordinary finger the adjustment is made by tapping it up or down, an operation which is very uncertain, besides consuming considerable time. In order to provide for fine adjustment, C. P. Thiel, Lawrence, Mass., has made the finger which is shown in the accompanying sketch, and re-



ports that he has found it very satisfactory. The shank of this finger was made of suitable size to fit in the holder provided for the old finger and was cut, for part of its length, with an 18 pitch thread. Over the threaded end is fitted the knurled nut D, which is used to feed the blade up and down. Through the center of the shank is drilled a 3-16-inch hole, while in the threaded end is cut a narrow slot that extends about one-half the length of the shank but opens only on one side. A piece of 3-16-inch wire, C, is split at one end and fitted with the blade B, which has a notch in its lower end for receiving the adjusting nut D. It will be clearly seen from the sketch how the parts are assembled and operated. Different blades with their stems can be made for different classes of work and used with the same shank.

STEEL LEGS FOR THE TOOL BOX.

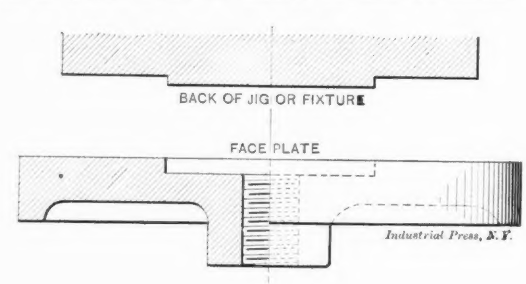
As is well known it is very unhandy to have the tool box set on the bench, owing to the fact that if anything be lying in front of it the bottom drawer cannot be opened readily. So it is customary to place the box on blocks that raise it about four inches above the level of the bench. As an improvement upon the use of blocks, R. A. Lachmann, Chicago, has fitted his tool box with steel legs, as illustrated in the sketch. In the first place four pieces of machine steel



¼x¾-inch, were drilled and tapped as shown in Fig. 2, and one of these was fastened to each lower corner of the box. These plates were let in flush with the sides of the box and secured with two wood screws. The legs were made from 3-16x¾-inch steel pieces as shown in Fig. 3 and were bolted to the corner plates by two ¼-inch tap bolts.

LOCATING WORK ON THE FACEPLATE.

Referring to the article, by Corneil Ridderhof, in January Machinery, in which he advocates drilling dowel pin holes in the faceplate, Geo. Henry writes: The object of the dowel pins is to locate a jig or fixture so that its center will be



located in line with the lathe centers. I have found a very convenient way of doing this is to turn a boss on the back of the jig so that the center of the boss will coincide with the center of the jig, and to bore a corresponding recess in the faceplate. Any number of jigs may be made to fit this recess and when putting a jig in place no time is lost in hunting for dowel pin holes. By employing this method the appearance of the faceplate is in no way injured.

* * *

An English novelty in sketch books for engineers and draftsmen, is a blank book with thin semi-transparent leaves for perspective drawings. A number of loose sheets are provided, with correctly drawn perspective lines, which are slipped under the blank page upon which the drawing is to be made. The perspective lines on the loose sheet show through in the same manner as the ruled lines often employed when writing on unruled paper. It is said that with this book true perspectives can be drawn without the use of a ruler or the determination of the vanishing points.

APPRENTICE SYSTEM OF THE BROWN & SHARPE MFG. CO.

At the works of the Brown & Sharpe Mfg. Co., Providence, R. I., a system of apprenticeship is in operation which has been found mutually beneficial to the firm and to its apprentices, for, while it obtains the results of their labor, they in turn are allowed the use of valuable machines and tools, at the same time receiving proper instruction in the modern methods of machine shop practice. The system, while being to a certain extent instructive, is not to be classed as a school, neither is it considered as such. The purpose is to make good machinists of the boys. Since the first apprentice was received by the firm 45 years ago over 300 have served an apprenticeship, a large percentage of whom are to-day engaged in directing or overseeing, either at Brown & Sharpe's or in other manufacturing establishments. The following description of the system was given by Mr. Mitchell Dawes, at a meeting of the New England Association of Teachers of Metal Work.

Applicants for admission to apprenticeship must be from 16 to 18 years of age, physically sound and have received an education equivalent at least to that required for graduation from the public grammar schools of the City of Providence. Personal interviews are preferred, but this not occurring, a photograph is required, with particulars as to health, sight, hearing, weight, and a statement as to the studies the boy has had and his advancement in each. If the applicant is found to possess the necessary qualifications, his name is registered and due notice given him when he will be required to commence work. The first eight weeks of service constitute a term of trial, during which both parties have an opportunity to determine whether they are agreed to continue the apprenticeship for the full term. The eight weeks above mentioned are counted as part of the first year's service and are paid for at the rate for that year. If everything is satisfactory at the end of this trial, an agreement is drawn up and entered into by Brown & Sharpe, the boy, and a parent or guardian, stating that, as the boy desires to become an apprentice to Brown & Sharpe for the purpose of learning the art or trade of machinist, Brown & Sharpe take him in their employ, and the boy agrees to become the apprentice of Brown & Sharpe in the machinist's art or trade, and to faithfully conform to their rules and terms of apprenticeship. The parent or guardian, in consideration of the covenants on the part of Brown & Sharpe, pay them as compensation for receiving the boy the sum of fifty dollars. Brown & Sharpe further agree, in case the boy shall serve the full term of apprenticeship and comply with the provisions of the terms of apprenticeship, to pay him at the termination of said term, in consideration of such faithful service, the sum of one hundred and fifty dollars. The term of service is four years, each year to consist of two hundred and ninety-five working days of ten hours each. The remaining working days in each year are allowed for recreation, as the Company may direct. Graduates of the Providence Manual Training School, well recommended by the principal, may have their term of apprenticeship shortened at the discretion of the Company.

Apprentices are required to perform their duties with punctuality, diligence and fidelity, and to conform to the rules and regulations which are or may be adopted for the government of the shops.

They are not allowed to use tobacco in the shop during working hours, and boys who smoke cigarettes are not accepted.

They make up lost time at the expiration of each year, at the rate of wages paid during said year; and no year of service commences until the apprentice has fully made up all time lost in the preceding year.

The Company reserves the right, whenever the state of business demands it, to shorten the hours of labor, or whenever for any reason it should stop the works, to suspend apprentices wholly or in part; and the making up of time so lost is at the discretion of the Company. The Company also reserves the right, in its sole discretion, to terminate its agreement with any apprentice; also to discharge him from its employment for non-conformity with its rules and regulations, want of industry or capacity, indifference to his duties or improper conduct within or without the shops.

Apprentices are paid for each hour of actual service, not including time allowed for recreation or time when work is suspended, the following wages: For the first year, 6 cents; for the second year, 8 cents; for the third year, 10 cents; and for the fourth year, 14 cents. If the company terminates the apprenticeship during the time of trial, it pays at the rate of six cents per hour for the time worked. Wages are paid on the regular pay days of the Company, as they may be established from time to time. The Company engages to faithfully instruct the apprentice in the machinist's art and trade, in their shops, during the term of apprenticeship.

When a boy begins work he is loaned a set of tools, consisting of a hammer, wrench, rules, calipers, dividers, etc., and a one-inch micrometer caliper. If he is accepted at the end of his trial term, these tools are sold to him and his name is marked on each. He is put under the personal supervision of a sub-foreman, who starts him on some of the simpler forms of work, such as centering and straightening, etc., and shortly after, he is given lathe work, roughing out mostly, always under the supervision of this foreman, and working from drawings almost from the start. As he learns he is advanced, according to his capability. During his apprenticeship, if the boy continues capable, he will probably have work on lathes, drill presses, milling machines, screw cutting, double tool lathes, scraping, planing, spindle work, erecting, assembling and general shop work, with work in the grinding and gear cutting departments, as the English method of making specialists is not followed at these works.

It should also be mentioned that a handbook for apprentice machinists is given them during their first year. This book is published by the Company, and was gotten up for this purpose. The rules, kinks and advice contained therein have become of much use to the boys. Should a boy come from a distance and have to board, a good place is selected for him, if requested, and he can go there at once on his arrival. This class of non-residents are closely looked after during their apprenticeship, particularly as to their habits, punctuality, and health; and they are put in the way of receiving proper medical attendance if ill at any time.

There are now 118 boys learning the machinist's trade at the works, and they are taking about forty boys a year. A large percentage of these are retained, the remainder being rejected or leaving of their own accord. Of those who complete their apprenticeship, a few are remarkably well qualified, over three quarters are good machinists, the rest are only passable.

Apprentices are allowed to have piece work or job work from time to time, thus earning extra compensation, and bringing into play oftentimes dormant faculties which, when once aroused, are ever after successfully made use of to their advantage. The boys of New England are naturally in the majority, though there are some from the Middle and Southern States.

An excellent library is maintained at the Company's expense, free for the use of all. It contains works on mechanics, history, travel, as well as a good class of autobiographies and works of fiction. It is well patronized. The boys are encouraged to attend the R. I. School of Design and the evening public schools, paying particular attention to drafting and mathematics. An incidental feature of a boy's apprenticeship at these works is an organization of the boys themselves, called the B. & S. Apprentice Association. This club furnishes a valuable means of cultivating a good spirit among them, as being at the works for a common purpose. They meet once a fortnight. The meetings last one hour, and this hour is allowed them. They discuss mechanical subjects, engage in debates, or are addressed by competent speakers selected for them by the Company. One feature in connection with this Association worthy of notice is their "question box." Members are allowed to deposit therein any written question pertaining to the trade they are learning. These questions are given to a Question Committee, which is appointed semi-annually; the subjects are investigated, and answers announced at the following meeting, and then turned over to the librarian, who keeps a record of both questions and answers for future reference.

From year to year, as the boys express an interest in what is going on in other shops, the fourth-year apprentices have been allowed to visit other establishments. Last year they visited the Prentice Bros. and F. E. Reed shops, and the Knowles Loom Works at Worcester, Mass., and reports of what they saw were given to the "stay-at-home" members of the Association.

The firm employs one man whose duty it is to look after the apprentices both in and out of the shops, see that they have fair treatment, proper instruction as to use of tools, settle any grievances, and also to see that on the boy's part he does not idle away his time, but puts forward his best efforts toward obtaining that which he came to learn. He encourages them to bravely bear disappointments occasioned by spoiled work, be manly, upright, neat, and specially careful, and he endeavors to impress on a boy's mind that he should get from a tool or a machine all that it is capable of standing, especially when roughing out work. They are taught that intensity of application, and concentration of purpose combined with natural qualifications, the environments notwithstanding, will surely help a young man to become a master of his chosen vocation.

In conclusion, Mr. Dawes says: The most noticeable failing about the young technical scholar who has been taught the use of tools and enters as an apprentice to the machinist's trade, is that he has no idea as to the commercial value of time, and it consequently takes a long time to teach him how to do his work in an economical manner. This is difficult, as he is imbued with the idea that he knows well how to work and use tools. Therefore, I would say that, in addition to what you now undertake, you also teach the boy how to work rapidly; and do not allow him to finish highly or spend time in polishing any part of the machine that is being constructed unless it is required by the designer or necessary for the smooth running of the machine in question. The majority of manufacturers do not buy a machine on account of its finish. Its utility is first considered, next the cost, and lastly the finish. The unnecessary finish that is often bestowed on a machine so frequently increases its cost that the probable purchaser is frequently led to select as good a working but plainer machine of another make.

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DOUBTFUL SOURCES OF POWER.

In a paper read before the Institution of Electrical Engineers by James Swinburne, December 4, 1902, various sources of power were discussed and their limitations pointed out. It has often been advanced that tidal power could be advantageously employed in many places where the rise is of abnormal height, but the author pointed out that calculated results were often fallacious. Take for a sample case, a tidal rise of 49.2 feet where an area of 10,764 square feet could be flooded. Into this space 529,710 cubic feet would flow twice daily, and, of course, the same amount outward, twice daily. On this basis the tidal enthusiasts figure a total equivalent fall of 196.8 feet for 529,710 cubic feet of water which would give 100 K.W. or 134 H.P. per day. But this is untrue because the average head is only 24.6 feet and this only holds at the periods of extreme high and low tides when the whole volume would have to be discharged in a few minutes. Such a system is unpractical. A system of tanks is described by which the power generated would be practically uniform, but it would provide only 10 K.W. or 13.4 H.P. and this at the periods of maximum tides. The power would be greatly decreased at neap tides.

As to "getting electricity direct from coal," the author is equally as discouraging. He says that it is the dream of the electro-chemist to devise an electrolytic cell in which the consumed electrode is carbon. But this he believes impossible. At ordinary temperatures carbon is practically inert. It forms no ions and therefore can give no electromotive force. At high temperatures oxygen, sulphur, silicon, and to some extent nitrogen, and many of the metals combine with carbon, but there is no dissociable salt of carbon formed. The carbon cell thus seems impossible.

ITEMS OF MECHANICAL INTEREST.

Thumb Screw Wrench — Reversible-jaw Chuck — Hardened Spindle with Soft Thread - Anti-friction Bearing - Key Duplicating Machine.

WRENCH FOR THUMB SCREWS.

The accompanying illustration shows a convenient form of wrench for tightening thumb-screws or for adjusting them when they are too hot to be handled. It consists of a strip of sheet steel cut and bent to the form shown, with the doubled

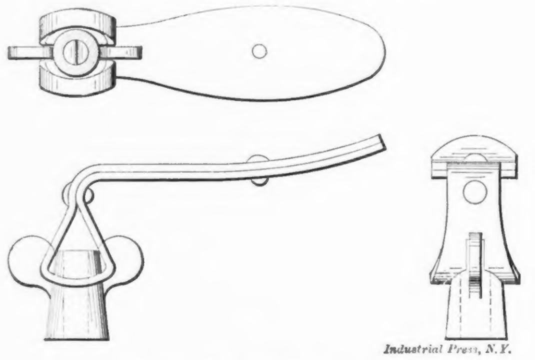


Fig. 1. Thumb Screw Wrench.

parts riveted together and one portion cut away for the reception of the thumb-screw itself. It is easily made and will form a handy tool for the purpose for which it is intended.—*G. L. F., Zeitschrift für Werkezengmaschinen und Werkzeug.*

ENGLISH REVERSIBLE-JAW CHUCK.

The idea shown in the cut of an English reversible-jaw chuck, is to mount each jaw on a little "turntable" so that it may be swiveled to any desired angle and then clamped by the bolts on each side, the bolt heads being engaged in circular T-slots which allow free circular movement. The ease with which the jaws may be reversed will appeal to almost every mechanic who might otherwise be inclined to unfavorably criticise the design. But while the reversible jaw

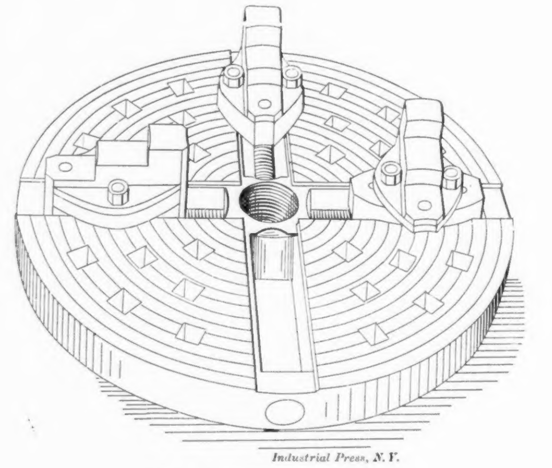


Fig. 2. Reversible-jaw Chuck.

feature is all right, it is not quite apparent what the advantage is in being able to clamp the jaws in any other but their normal positions unless it might be in holding some odd-shaped pieces that are rarely met with in lathe work. The makers of the chuck, H. W. Cowley & Co., Bolton, Eng., make a strong claim for this feature, saying that it is one not possessed by any other chuck.

HARDENED LATHE SPINDLE WITH SOFT THREAD.

On the occasion of a call at the shops of the Waltham Watch Tool Co., Springfield, Mass., a few weeks ago, Mr. Van Norman called our attention to the manner in which they make bench lathe spindles hardened all over and still obtain a soft thread for the chuck. It is scarcely necessary to explain that it is highly important to have the spindle nose

of a precision lathe (or any lathe for that matter) truly threaded, or that, in the ordinary course of events, if the thread is cut before the spindle is hardened, it will not run truly with the axis afterward. So about the only course of procedure left open in making a hardened tool steel spindle with nose thread integral, is to harden it leaving the nose portion soft, and then to cut the thread, since it is scarcely feasible to grind the thread after hardening, although we believe this is sometimes done.

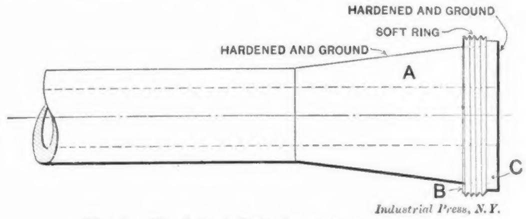


Fig. 3. Hardened Spindle with Soft Thread.

The manner in which the Van Norman bench lathe spindle is made so as to accomplish the end of getting a soft portion for threading after hardening, is shown in the cut. The spindle, which is made with taper bearings, the taper of the tail bearing being opposite to that of the head bearing, is made with a collar *C* at the end. A portion of the spindle back of this collar, is turned straight, for a short distance, for a seat. After the spindle has been hardened and ground, a soft steel collar *B* is heated and slipped over the tail end, and shrunk onto the seat next to the shoulder. The ring is then threaded for the chuck, and forms a sort of external nut, so to speak. The chuck faceplate is made with a face inside the bore, to bear against the ground face of the spindle, *C*.

GERMAN INSERTED CUTTER LATHE AND PLANER TOOL.

"Of the making of books there is no end," might with equal appropriateness be applied to inserted cutter lathe and planer tools. A German device in this line, which is said to be new, is made by C. Scharenberg, Berlin, Germany, and is shown in two styles in the cut. The locking pin *A*, is made with a squared head at each end and an eccentric groove in the middle. This pin is, of course, located in the holder so that when turned to a certain position the eccentric groove allows the cutter to be freely inserted. Then turning the pin locks the cutter firmly in place, the movement being in the direction of the pressure on the tool which thus has a tendency to increase the "bite" the heavier the cut. The locking pins for some styles of holders, are also made with only one squared head, the other head being made flush with the side of the holder for work having shoulders.

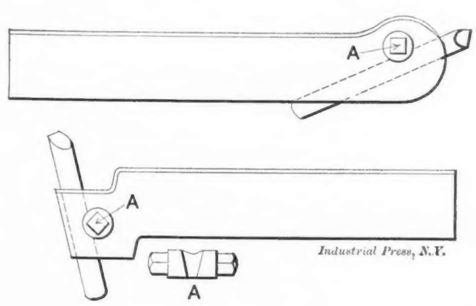


Fig. 4. German Lathe and Planer Tool with Inserted Cutters.

NOVEL ELECTRIC "STAB" SWITCH.

One of the difficulties of handling electric currents of several thousand volts tension is the arcing at the switches. In fact it is impossible to break a high tension current with an ordinary knife blade switch without an electrical display of an appalling and dangerous nature. To overcome the arcing of high tension currents, oil switches have been developed in which the electrodes are submerged in oil which extinguishes the arc when the switch is opened. A recent improvement in switches for moderately high voltages, is known as the "stab" switch. It consists of a thick fiber tube suitably secured to the marble switchboard in a horizontal position, the greater portion of the tube projecting from the back side of the board. The terminals are at opposite ends of the tube, being designated in the cut as *D* and *D'*. The switch is made in the form of a dagger, the tube forming its sheath. When the dagger is in the sheath the current is "on," and when it is withdrawn the current is broken. To smother and extinguish the arc between the terminals a marble ball *B* is provided which falls

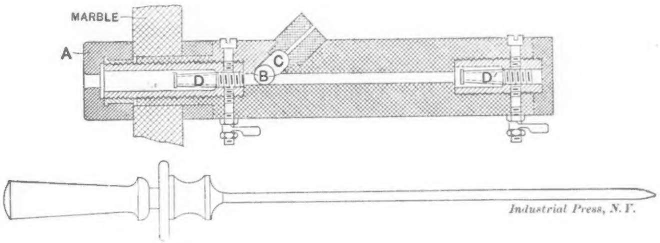


Fig. 5. New Electric "Stab" Switch.

down from the pocket *C*. When the dagger is pushed back into place to close the circuit the ball is pushed up into its pocket. This switch is said to work satisfactorily up to 6,000 volts.

NEW SYSTEM OF AUTOMATICALLY OILING PILLOW BLOCKS.

This oiler consists of a wooden friction roller mounted upon a removable lever which, together with the roller, can be readily removed without the aid of tools, even while the journal is in motion. The contact of the roller with the bottom of the journal is insured by the counterweight at the other end of the lever, the whole being carried on a knife edge set close to the roller and resting on the bottom of the box. The device is placed in a cavity cast in the side of the box, and which is closed by a cap at the top.

The operation is at once apparent. The roller runs in the oil placed in the bottom of the box to the depth of from 1 inch to 1½ inches, and being turned by its contact with the journal carries the oil up with it to accomplish the lubrication. The advantages claimed for this new application of an old principle are that oil is delivered in ample abundance to the journal, that the lubrication is constant regardless of the level of the oil and that the roller does not agitate the oil so as to cause it to become oxidized, but runs in it smoothly and quietly.—*G. L. F., L'Echo des Mines et de la Metallurgie.*

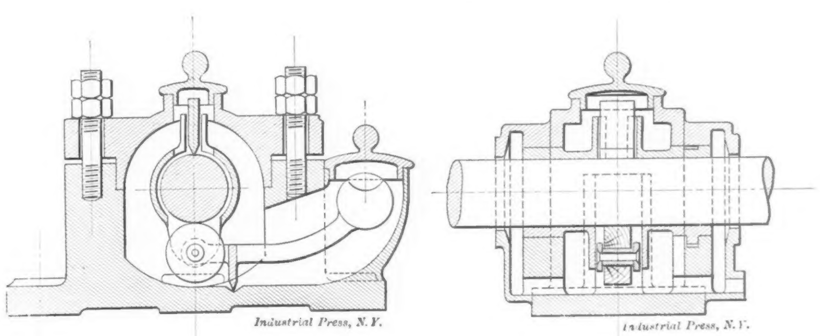


Fig. 6. Automatic Pillow Block Oiling Device.

A NEW ANTI-FRICTION BEARING.

It is a well-known principle in mechanics that the friction of a shaft journal is in direct proportion to its diameter, the smaller the diameter the less the frictional resistance to rotation. But there is a practical limit below which it is not possible to reduce the diameter of a shaft for any given load for the simple reason that it would lack strength and rigidity to support the load. For this reason a pivot is often used as an anti-friction journal in light machinery, especially in timepieces. But the use of the pivot for heavy work, is barred by lack of both strength and bearing surface. To lengthen a cylindrical journal in order to give a small shaft sufficient area to support a given load, would make a long, slim piece possessing little rigidity and one that, as ordinarily supported

following the usual plan of construction, would be entirely unpractical. But it appears that there is the possibility of using extremely long, slim journals for rotating parts if the internal member or shaft is held stationary and under considerable tension.

The *American Manufacturer*, of recent date, contains a translation of an article appearing in *La Machine*, which describes the invention of a German, H. Ganswindt, for substituting a plain bearing for ball and roller bearings where it is desirable to reduce the frictional resistance to a minimum. The idea is to use a crucible steel wire stretched between supports for the wheel or other rotating member to turn upon,

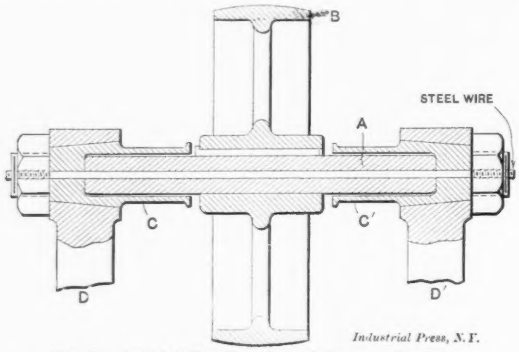


Fig. 7. Anti-friction Bearing of German Design.

the wire, of course, passing through the exact center of the hub the same as if it were an ordinary journal. Such a journal derives its strength from the fact that to fail it must be cut by shearing action, its tension preventing bending or twisting action. Crucible steel, especially hard-drawn piano wire, is very tough and meets shearing stress with great resistance. Ample bearing surface is provided by the length which may be whatever required. The accompanying illustration shows the typical construction for a pulley. The steel wire *A* is stretched between the rigid supports *D D'*. The long hub of the pulley is surrounded at the ends by cupped pieces *C C'* which are for the purpose of retaining the pulley in place should the wire break. Whether this precaution is made necessary by frequent breakages of the wire, we are not informed, but, of course, it is a reasonable safeguard.

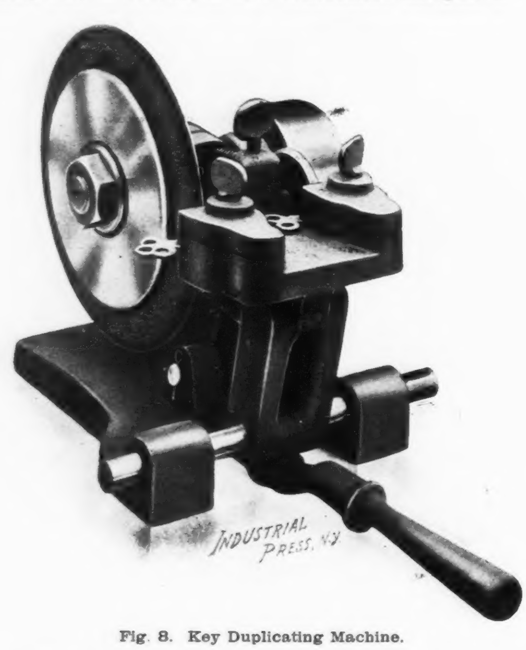


Fig. 8. Key Duplicating Machine.

Tests have shown that a wire .016 inch in diameter is of ample diameter to support a pulley weighing 200 pounds, the length of the bearing being, of course, proportioned to this weight. Thus mounted, a 200-pound pulley was given an initial velocity of 120 turns per minute, and it continued to run longer than when supported on the best ball bearings. It should be understood that no lubrication whatever was used with the stretched wire bearing in this case while the ball bearings were lubricated. Where the nature of the machine is such that motion from a rotating shaft need not be transmitted beyond the journals, it would appear that in some special cases this form of bearing might be superior to ball bearings, especially where vibration is considerable.

A KEY DUPLICATING MACHINE.

One of the tasks most frequently encountered by the locksmith is the duplication of flat or corrugated keys of the Yale and Corbin types. This has heretofore been a case of "cut and try," employing as tools the vise and file. As this is a comparatively slow and arduous task an ingenious locksmith has devised a machine by which keys may be duplicated by the use of the emery grinding wheel. One of these machines is shown in the accompanying cut. This is arranged to be driven by a one inch leather belt but for small shops, where power is lacking, a hand driving attachment is supplied. As will be seen in Fig. 9, there are two small clamps mounted on a swinging arm which, by means of a hand lever, may be moved from right to left parallel with the spindle of the machine. The key that is to be duplicated is placed in the right hand clamp. Bearing against this key is a hardened steel disk

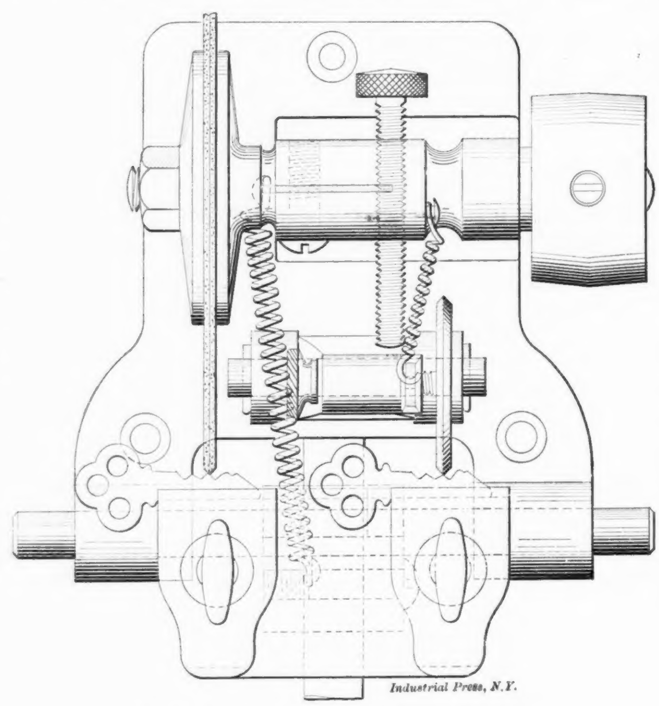


Fig. 9. Detail Plan of Key Duplicating Machine.

having a V-shaped edge and adjustable so that the edge bearing against the key will be in line with the V-shaped edge of the wheel. A stiff spring keeps the key always in contact with the guiding disk. The effect of this arrangement is that as the key is passed back and forth by means of the hand lever, the guide disk, sinking into the depressions of the key, allows the wheel to grind corresponding depressions in the blank and thus the edge of the blank is cut to an exact duplication of the original key. In this way a key may be duplicated in about one minute. The machine is manufactured by the Builders' Iron Foundry, Providence, R. I.

* * *

"The perpetual motion crank," said a patent office chief of division, "is with us always, knocking at every door of every department. His mechanism is not only to run itself, but is to supply the power for machinery of all kinds, sewing machines, clocks and everything else. When we suspect that an applicant has the perpetual motion bee in his bonnet, we ask for a working model. That is the last we hear of it. A few months ago I received a long letter from a young man in New York, saying that he was sure he had discovered perpetual motion. I treated the matter seriously and wrote him not to go to the expense of employing attorneys or making an application, but to get up a working model, and after it had run several months to let me know, and I would advise him further. Six months later I received a postal on which he had written simply the words: 'Machine wouldn't work' "—*Washington (D. C.) Star.*

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published

6. T. D. S.—Will a pump with two 4-inch pistons and a $3\frac{1}{2}$-inch suction raise water 22 feet through a 6-inch suction line as well as through a $3\frac{1}{2}$ inch line? There is a foot valve on both lines and the 6-inch line is connected to the pump by about 18 inches of $3\frac{1}{2}$ inch pipe. If not, please explain.

A.—Theoretically the larger pipe would be the better arrangement, but owing to the difficulties of priming and those caused by entrained air and leakage around the joints it is very doubtful if the 6 inch suction could be used as successfully as the $3\frac{1}{2}$-inch.

7. T. M.—If a man running a planer or shaper takes a cut $\frac{1}{4}$-inch deep with two teeth feed and then a cut $\frac{1}{2}$-inch deep with one tooth feed, which takes the most power, or will the power required be the same?

A.—There would, in theory, be no difference in the power required, since the amount of metal removed would be the same in either case. Some difference, however, might occur owing to the tool being shaped so as to break up the chips more readily for one cut than the other, and this might cause a slight difference in the amount of power required, but this is as likely to occur in one case as in the other.

8. L. G. G.—Can you tell me whether the American inch is the same as the English inch; or whether there is a difference in the measurement, and in what it consists?

A.—The two are the same. The legal standard in England is a bar of bronze, 38 inches long by 1 inch square cross section, into which two gold plugs are imbedded, about 36 inches, center to center. The exact distance of 36 inches is measured between lines scribed on these plugs. Forty copies of the bar were made, which were intended to be of standard length at a temperature of 62 degrees Fahr. One of these known as Bronze No. 11, was presented to the United States Government in 1856. Through a minute error in scribing the lines, Bar No. 11 is standard length at a temperature of 61.79 degrees instead of 62 degrees. While the meter is the legalized standard in this country, the yard, taken from Bronze No. 11, is the commonly accepted standard.

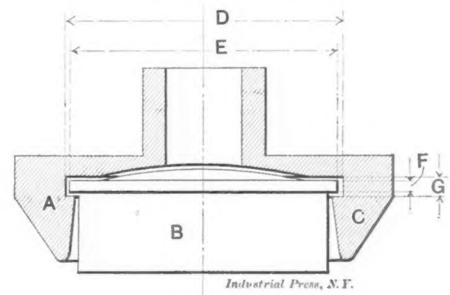
9. J. R.—In a loom a shuttle has to be thrown from side to side, a distance of about 6 feet, 200 times a minute. Some of these shuttles are lighter than the others, and these have to be thrown at higher speed to get across in time. Does the higher speed require more power? 2. I can throw a piece of wood weighing 5 pounds further than a piece of iron weighing 20 pounds, but a 4-ounce piece of iron can be thrown further than a one-ounce bag of feathers. Are these seeming contradictions caused solely by the air resistance, or does some other factor have to be considered? 3. We wish to throw a pound weight so that on delivery it will have attained a velocity of one mile per minute and will have acquired that speed in a distance of one foot. How much energy will be required, and what is the rate of acceleration?

A.—1. Not necessarily, since the friction and other resistance encountered by both the light and heavy shuttles might be the same, in which case the same energy would be required for both. But in order that the same energy be imparted to the lighter shuttle, it is necessary to deliver it at a higher velocity. Energy of a moving body increases as the square of the velocity. Thus a piece weighing one pound must be given two times the velocity of one weighing 4 pounds in order to have the same energy. 2. In the case of the piece of wood weighing 5 pounds and the iron weighing 20 pounds, the difference in distance thrown is, of course, caused by the difference in weight, but in the case of the 4-ounce piece of iron and one-ounce bag of feathers the difference is caused by the air resistance, being proportionately greater for the feathers than the iron. In a vacuum a coin and a feather fall at the same rate. 3. A pound weight projected with a velocity of one mile per minute, has a speed of 88 feet per second. A force of one pound acting on a pound weight a distance of one foot in a horizontal direction, will impart to it a velocity of practically 8 feet per second, the velocity being the same as though the weight fell freely through a distance of one foot. From the formula for falling bodies, $v = \sqrt{2gs} = \sqrt{2 \times 32.2 \times 1} = 8.02$ feet, in this case. Now, since with an acceleration the same as that of gravity, a velocity of 8 feet per second is imparted in a distance of one foot, to give the same body a velocity of 88 feet per second in the same distance, or one foot, the force must be $11^2 = 121$ times as great. Hence the rate of acceleration is $32.2 \times 121 = 3{,}896$ feet per second and the energy required would be 121 foot pounds. It should be understood that the 121 foot pounds of energy refers only to the actual weight thrown and no account is taken of the weight of the impelling apparatus.

10. A. H.—Bearing on the subject of large gas engines, treated in your last number, I have seen it stated that it would be possible to produce power at less cost for fuel with a gas engine using blast furnace gas than with the best steam engine, using coal under a boiler for generating steam. In this case the pig iron would be considered a by-product. If such a thing is possible, why should not blast furnaces be erected near our great cities, primarily for power purposes?

A.—We have heard this same plan suggested, and it certainly is a novel proposition. But we think it would not be correct to consider pig iron wholly as a by-product. It must be remembered that even if the smelting of the ore could be done for nothing, so to speak, the ore would still have to be paid for and there would also be the interest on the investment in the apparatus, the cost of attendance, etc., which would be much greater with a blast furnace and gas engine installation than with a steam plant of corresponding power. We think, moreover, that the figures by which it is calculated that the actual cost of producing the power is less with the blast furnace gas engine, have been somewhat overdrawn. From the best data available, it may be assumed roughly that 900 horse power can be realized per ton of iron produced, and that one pound of fuel is required to produce one pound of pig iron. There would thus be 900 horse power generated with an expenditure of 2,240 pounds of fuel, or about one horse power per 2.5 pounds of fuel. While this figure is very favorable to the gas engine, it is easily exceeded by large steam engines. Unquestionably the utilization of the waste gases from blast furnaces will reduce the cost of making pig iron very materially, but we do not think the production of power by this means will ever be of enough importance to warrant calling the pig iron a by-product.

11. Baer & Rempel.—Kindly submit the following to your readers: The sketch shows two cylindrical bodies, *A* and *B*, the latter having a circumferential rim *E*, which engages a circular race *D* of piece *A*. Diameter of race *D*=1 1-32-inch, width *G* of same = 1-16 inch. Diameter *E* and width *F* of the rim are 5-1000 inch smaller. Piece *B* is kept stationary, while piece *A* is fixed on a shaft and revolves at a very



high speed. Both of the pieces are hardened and the difficulty lies in grinding race *D* after hardening so that rim *E* will run smoothly in it with no larger space between them than 5-1000-inch. In order that piece *B* may enter into race *D*, rim *C* is cut partly away, which is not shown in the sketch. Perhaps some of the readers of MACHINERY may be able to suggest a method of doing the job in a satisfactory manner

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

THE 2 x 26-INCH NEW MODEL TURRET LATHE.

The Pratt & Whitney Co., Hartford, Conn., have just brought out a 2 x 26-inch turret lathe which is in the same general line of construction as their ⅝ x 4½-inch and 1 x 10-inch lathes described in the December issue of MACHINERY, but with such additions as are necessary to make it suitable for the heavy work for which it is designed. The headstock, bed and pan are in one piece, as on the smaller machines, and the spindle is provided with three-step cone and double-friction back gears so that, with the three speed counter-shaft, eighteen spindle speeds are available.

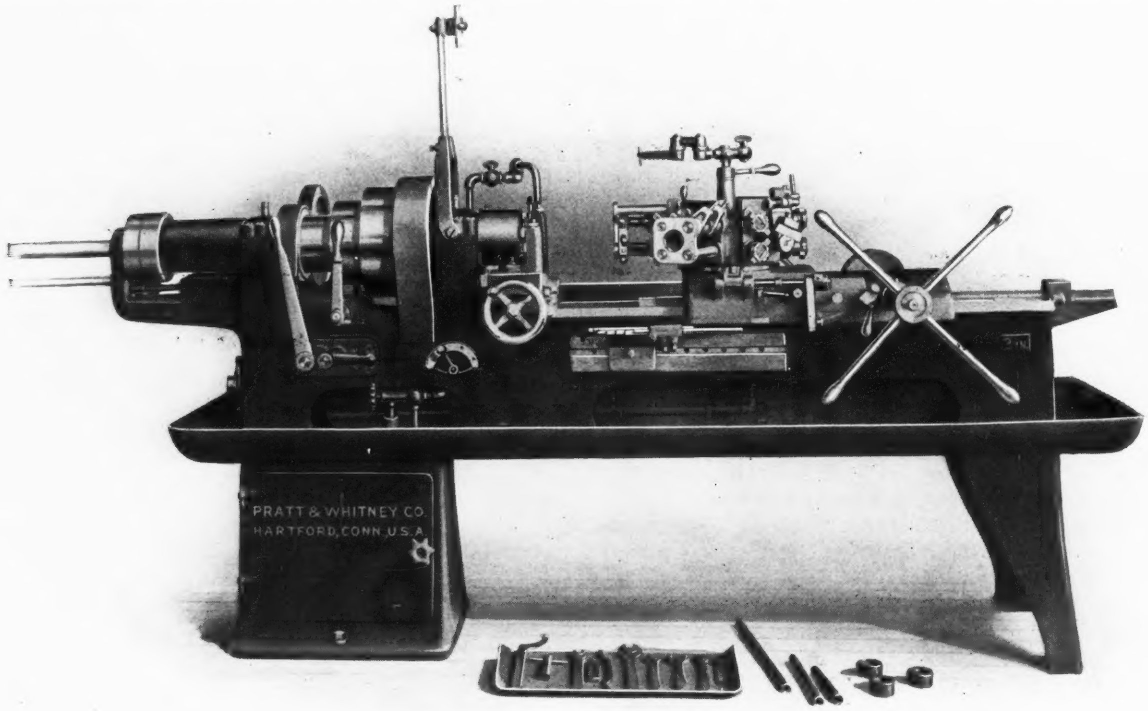


Fig. 1. The 2 x 26-inch New Model Turret Lathe.

The collet, which is used on all sizes of these machines, is so constructed that it closes without advancing or withdrawing the stock. This is a particularly useful feature when the machine is .nployed for "second-operation" work. The construction will be clearly seen by reference to Fig. 2. *A* is the collet proper; *B*, a spring; *C*, the closer; *D*, a cap screwed on the end of the spindle *E*; *G* is the plunger and *H* a tool steel liner. The line of contact between the collet and the nose-piece is tangent to a circle struck from the center of the spring-hole in the collet, and this contact is made positive by the spring *B*, thereby excluding dirt from the interior of the nose piece. When the plunger *G* is withdrawn, the spring *B* forces back the closer, *C*, and allows the collet to open. The liner *H*, pressed into the nose-piece, fits the closer accurately and keeps the collet in alignment with the bearings.

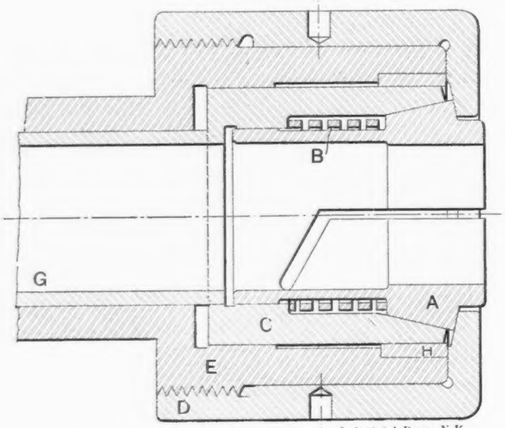


Fig. 2. Collet and Collet Closing Mechanism.

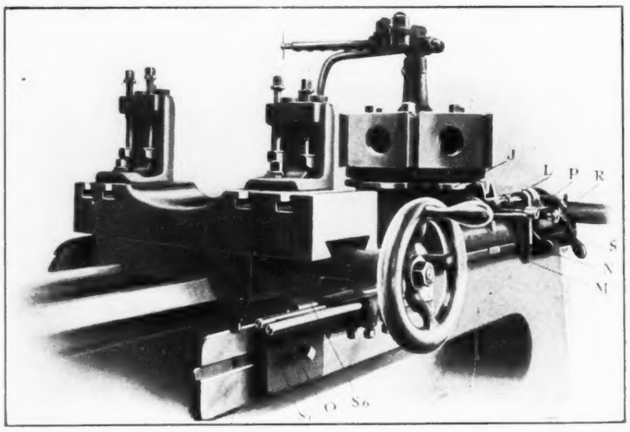


Fig. 3. Double Cross Slide and Turret.

For use with the rod feed an auxiliary stop is provided and this, when not in use, may be swung up out of the way as shown in Fig. 1. The rod feed mechanism is of the roller type. It is adjustable for a wide range of sizes and is adapted to handle rods of most irregular section as well as rounds. It consists of two circular shells, one of which is mounted on the spindle and contains three grooved driver rollers with their axes at right angles to the spindle axis. These rollers are clamped upon the rod when the collet is opened and rotate the rod with the spindle, though not of themselves advancing it. The other shell is fixed to a bracket extension on the headstock and does not rotate. It contains three feeder rollers whose axes make an angle of about 20 degrees with the axis of the spindle and are adjustable radially, as are those in the revolving shell. Springs keep both sets of rollers in contact with the rod when the collet is opened and allow for slight variations in the size of the stock. The rod

being in contact with both driver and feeder rollers when the collet is opened, is given a forward motion until it comes in contact with the stop. When the collet is closed the feeder rollers are withdrawn from the stock.

The turret and turret slide are of the same general construction as has already been described for the smaller machines, but with the addition of a power feed. This feed is put into operation by pushing in the knob shown at *R* in Fig. 3; a movement of the short lever *S* throws it out of operation. The power feed is driven directly from the spindle by means of a Renold silent chain and has four changes of speed which are operated by a single lever located on the front of the machine below the headstock.

The double cross slide has gear-driven power feed with four speeds in either direction, automatic knock-off and hand feed operated through handwheel and screw. The power feed of the cross slide is thrown into operation by pushing a small knob on the front of the slide. It may be thrown out by hand at any point in the travel, while adjustable stops are provided for both hand and power feed. Each cross slide tool rests on two supporting steps which are in turn carried by screws, the knurled heads of which appear behind the square head setscrews. Raising or lowering one or both of these steps after the setscrews are slackened changes the height or angle—or both height and angle—of the cutting tool, after which it is clamped by the setscrew in the required position. The oil pump, which is located on the back of the headstock, is provided with a separate belt drive, rendering the oil supply entirely independent of the running of

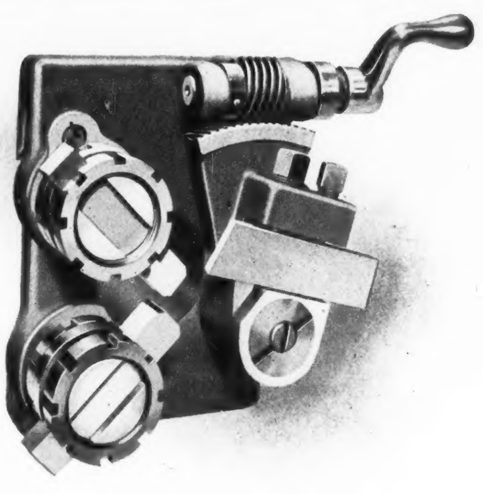


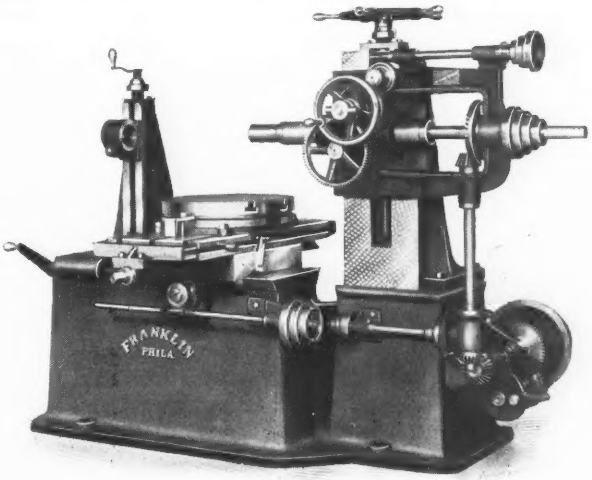
Fig. 4. Squaring and Recessing Tool.

the spindle. The oil tank is located in the cabinet leg. The countershaft has three speeds, which are operated by a single shifting lever. It also has tight and loose pulleys for driving the oil pump.

The turret tools comprise the single and multiple roughing and finishing tools, similar in construction to those described for the smaller machines; pointing tool with cutter and back rest; the style *D* self-opening die-heads, with roughing and finishing adjustment; and single turning tool with tangent cutter having squaring and recessing attachment, cutter and back rest. The latter tool is illustrated in Fig. 4. The tangent cutter is mounted in a swinging holder, the top of which is made a segmental worm gear. This meshes with a worm that is operated by a crank on the back of the tool, which enables the cutter to be fed across a square shoulder, for finishing. When it is desired to use it as a recessing tool, in place of a forming tool, the cutter is drawn back until it clears the work. The turret is fed forward to the point at which the recessing is to begin and with the slide feed out of action the tool is fed in to the required depth of the recess. The slide feed is then thrown in until the desired length of recess is covered, when the tool is withdrawn. The use of this tool in many cases renders possible operations that would otherwise have to be done on a lathe as a second operation. All of the turret tools, with the exception of the die-heads, are dovetailed and gibbed to the several faces of the hexagonal turret. The hole through the back is of sufficient size to allow stock up to the full size of the largest collet to pass completely through the turret.

TOOL ROOM BORING MACHINE.

The photograph illustrates the new "Franklin" tool room boring machine, built by the Franklin Machine Works, Inc., Philadelphia, Pa. As its name implies, it was designed especially for all-around service in the tool room, but it is constructed rigidly and heavily enough for use in the shop for

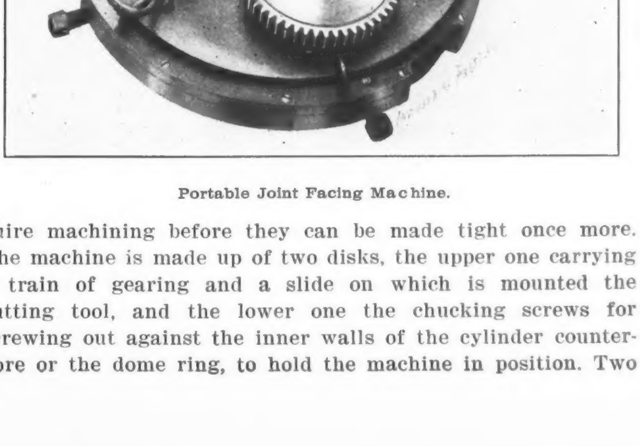


Tool Room Boring Machine.

accurate boring, facing and milling. The spindle, which is of crucible steel, is two inches in diameter and has a wide range of feeds for boring and drilling. A feed is also provided for the table so that the machine can be used for milling. The lifting screw is provided with dial for micrometer adjustment of spindle head so that the milling cutters can be accurately set to any required depth. The circular table is designed to be readily placed on or removed from table, and is accurately graduated and aligned for work of great precision. The driving cone has three steps and is backgeared, thus giving changes of speed. The gears are steel castings and are of ample strength for any work within the capacity of the machine.

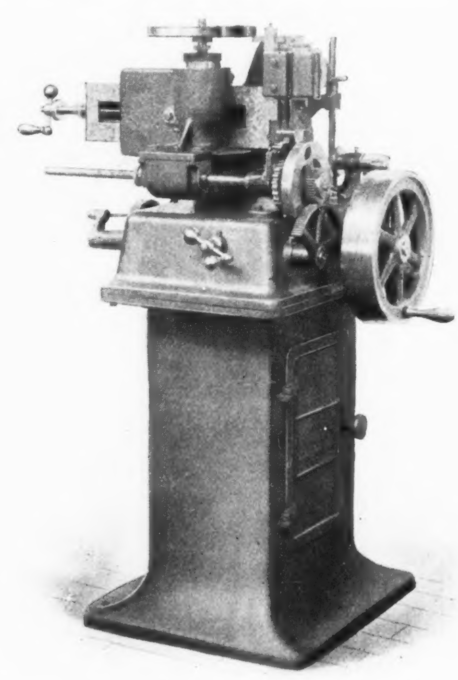
PORTABLE JOINT FACING MACHINE.

The portable machine shown herewith is one that should be found useful in railroad shops and in jobbing establishments doing repairs to steam engines and boilers. It is a machine for refacing cylinder head joints, dome cap joints and similar parts that have become leaky in service and re-



Portable Joint Facing Machine.

quire machining before they can be made tight once more. The machine is made up of two disks, the upper one carrying a train of gearing and a slide on which is mounted the cutting tool, and the lower one the chucking screws for screwing out against the inner walls of the cylinder counterbore or the dome ring, to hold the machine in position. Two



Universal Graduating Machine.

of these screws are shown in the cut. Besides the gearing shown there are three reduction gears in the space between the two disks, to reduce the speed and to give power to drive the tool. The cutting tool is mounted on a steel slide which may be fed out automatically, or by hand. The crank seen in the illustration is for quickly moving the tool to the required position, then the feed clutch is thrown in and the crank removed, the machine feeding automatically as the handwheel is turned. The machine may be driven by hand or power; when power is employed a pulley or coupling is substituted for the handwheel. Hand power is generally used, as the time required for facing one joint is so short that it does not usually pay to connect to any other source of power. H. B. Underwood & Co., Philadelphia, are the manufacturers.

IMPROVED QUICK-FEED GEAR BOX.

Schumacher & Boyé, Cincinnati, Ohio, have recently redesigned and improved the feed gear box used on their lathes so as to greatly increase the range of feeds that can be obtained. In the photographs, Fig. 2 shows an end view, and Fig. 1 the front, of the arrangement for feeds and screw cutting that is now being used on all lathes of their make, from 16 to 32 inches inclusive. Power for operating the feed is delivered from the lathe spindle to the gear box, through reverse and intermediate gears, and thereby operates the spindle *A*, which extends the full length of the box. Upon this spindle, and keyed thereto, is a sliding gear which is moved by means of a yoke to any desired position along the spindle. Upon the upper edge of the yoke is a rack which meshes with a pinion keyed to the small shaft *B*. This pinion is turned by a short crank *H*, the handle of which contains a spring pin that may engage any of the eight holes in the feed disk *C*, thereby locking the slide-gear at any one of eight desired positions along the shaft *A*. The back of the yoke forms a plate, and has a series of eight holes corresponding to those in the feed disk and for each position of the pin in the feed disk a corresponding hole is brought into place in the slot shown in the front of the gear box. In a swinging bracket, which pivots around an extension of the lead screw *E*, is a cone composed of eight gears, which may be placed in mesh with the slide-gear. Upon the end of the gear cone shaft, which extends beyond the gear box toward the tail end of the lathe, is placed the gear that drives the lead screw so that by moving the slide-gear to its different positions, in mesh with the gears of the cone, eight different speeds of the lead screw are obtained. The swinging bracket is held in place by a spring pin in the handle *F*, which fits that hole in the yoke-plate which is exposed by the slot in the box, above referred to. These holes are so placed that when the pin is in position in the yoke-plate the slide-gear will be in mesh with the cone gears.

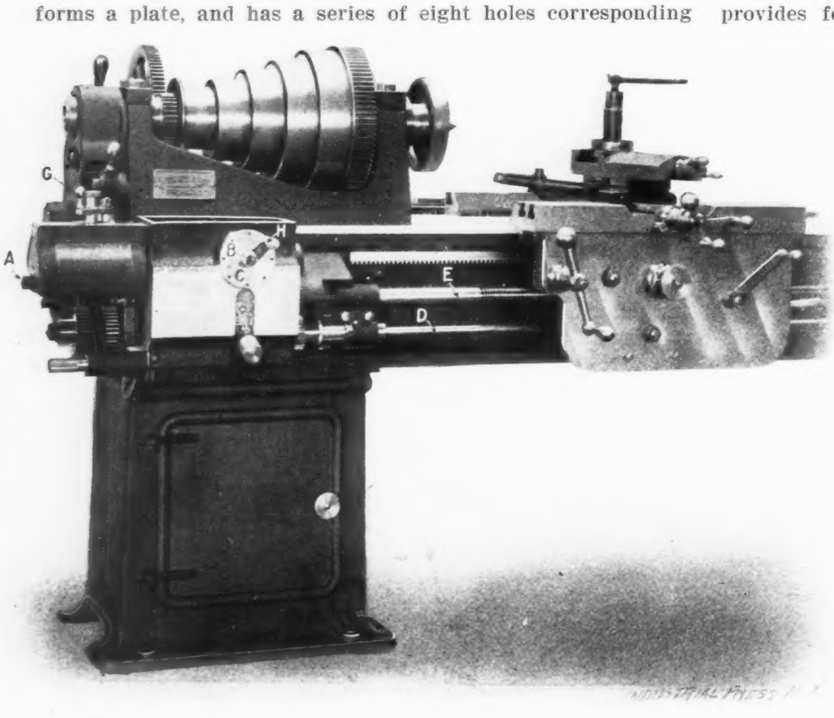


Fig. 1. Front View of Improved Feed Gear Box.

Upon the left hand end of the shaft *A* is mounted a second slide gear which, by a movement of the handle *G* over its dial, can effect five changes in the rate at which the spindle *A* is driven by the lathe spindle. This is accomplished by a set of compound gears that are mounted in the intermediate gear bracket.

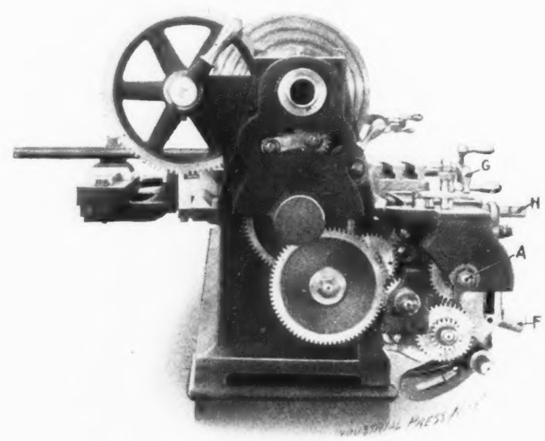


Fig. 2. End View of Improved Feed Gear Box.

To operate the mechanism: first disengage the pin *F* and allow the swinging bracket to drop, then move the crank *H* so as to bring the slide gear into mesh with the desired step on the gear cone, as indicated by the figures on the dial *C*, re-engage the pull pin with the hole in the yoke plate. This provides for any of the eight changes of speed obtainable from the gear cone. By dropping the intermediate gear bracket, the secondary slide-gear may be placed by means of the crank *G*, in mesh with the intermediate gears, so as to give five additional changes, and as these multiply those obtained from the gear cone we get a total of forty changes of speed available.

For feed changes it is necessary only to move a sliding gear along the feed rod *D* so that it will engage with a gear on the lead screw from which the feed rod is driven at a rate of four to one, *i. e.*, if we desire to obtain a feed of forty per inch, the lathe would be geared for cutting ten threads per inch when, with the feed rod in action, this feed would be obtained.

UNIVERSAL GRADUATING MACHINE.

The photograph on page 334 illustrates a new graduating machine that has been brought out by the Springfield Machine Tool Co., Springfield, Ohio. It is designed to divide circles into degrees or such divisions as are necessary to use in connection with screws of different pitches to allow each division to equal a movement of .001 inch. It is in some respects similar to an automatic gear cutter and, when once set for graduating a piece of work, is entirely automatic in its action. Provision is made, in connection with a cam, for long and short strokes so that the graduations may be more easily read. Owing to the fact that irregular pieces have to be graduated, such, for example, as compound slide rests, it has been thought better to hold the work vertically, since the use of a horizontal spindle would tend to destroy the accuracy of the results. The work is accordingly held on a vertical spindle, which revolves in a slide, adjustable to and from the graduating bar.

Oblique Tumbling Barrel.

The machine may be operated either by hand or by power, each revolution of the driving pulley representing one stroke of the graduating bar. Experience has shown that a speed of about one hundred strokes per minute will give the most satisfactory results. The graduating bar is operated by means of a small rack and pinion, driven through the intervention of four bevel gears, to which motion is given by a connecting rod whose upper end is connected to a link and whose lower end rolls on the cam, which is provided for giving the different lengths of stroke required for graduating operations. The link is so arranged that the cutting stroke of the graduating bar may be either upward or downward, according to requirements. This is accomplished by shifting the connecting rod from one side of the link to the other, while shifting it toward or away from the center results in a longer or shorter stroke of the graduating bar. The slide which holds the graduating bar may be swiveled to any angle, so that any form of surface which requires graduating, may be operated upon.

The indexing mechanism is positive—a pawl and ratchet being used to drive same and a form of pawl, plunger and ratchet is used to hold same in position during the cutting. Inasmuch as the indexing is done on the return stroke of the graduating bar and as all the movements bear a positive relation to each other, the danger from error is almost entirely eliminated.

The slide which carries the head for the graduating bar is adjustable up and down on the frame of the machine by means of the ball crank shown, which extends in the front of the machine. No provision has been made for relieving the cutting tool on the return stroke, inasmuch as it has been found that eminently satisfactory results may be obtained without this complication.

OBLIQUE TUMBLING BARREL.

The latest production of the Globe Machine & Stamping Co., Cleveland, Ohio, is the oblique tumbling barrel which is shown in the accompanying half-tone. These barrels are adapted for cleaning, brightening and polishing sheet metal stampings, small iron or brass castings, rods, pins, etc. They may be used for either wet or dry tumbling. By means of the hand-wheel the barrel may be raised to a nearly upright position or tilted down, as shown in the cut, so that the contents may be dumped out. It may be run in either of the extreme positions or at any intermediate position. Thus the most delicate stampings or castings may be finished without danger of distortion or breaking. A ratchet and pawl are provided which hold the barrel in any desired position. The ease and quickness with which the barrel may be emptied of finished work makes the tilting feature very desirable.

AUTOMATIC WORM AND SCREW THREADING LATHE.

The rapid and economical production of accurately threaded steel worms and screws of considerable size is receiving more attention from machine builders than ever before. High speed electric motors, and their use for driving heavy machinery, has created a large demand for worm devices, that being the principally adopted means of speed reduction, notwithstanding the high cost of the worm itself. Modern designers of automatic devices here find a fruitful field where a short time since it was thought no improvement could be made. Until recently no method of accurately threading worms and screws was known, other than with an engine lathe. The engine lathe is one of the oldest tools we have; very few radical changes have been made in it for many years; additions and modifications, to be sure, and automatic lathes for various purposes, but a threading lathe wherein all movements of spindle and feed were wholly automatic, requiring no attention of operator after he has placed the work between the centers has been reserved for later times.

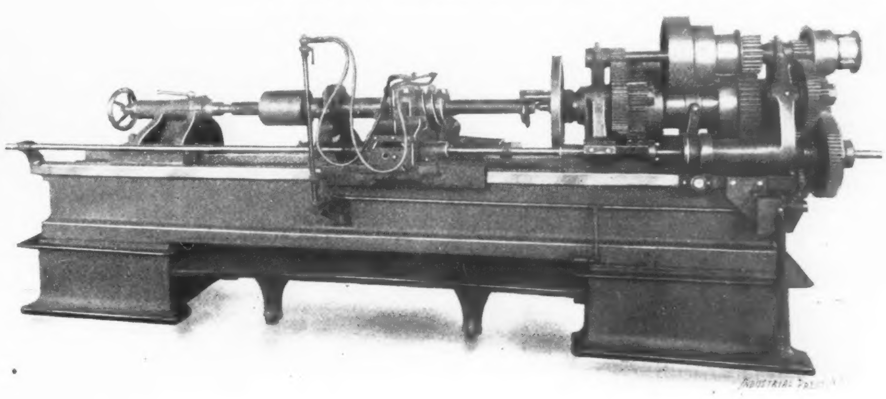


Fig. 1. Automatic Worm and Screw Threading Lathe.

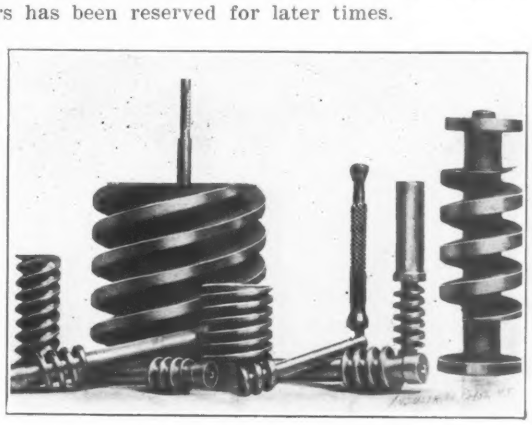


Fig. 2. Worms and Screws cut on Automatic Lathe.

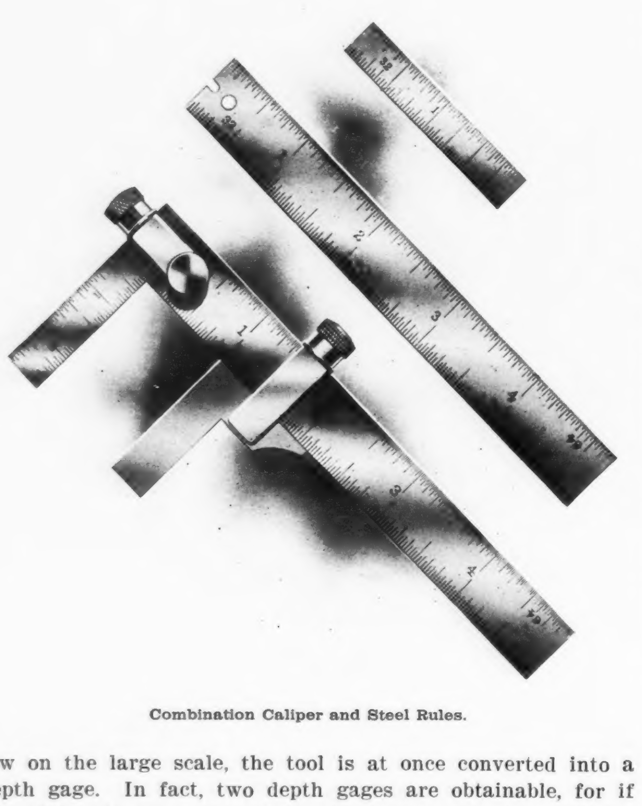
The automatic threading lathe, for threading small screws up to about $2\frac{1}{2}$ inches in diameter, has been built by the Automatic Machine Co., Bridgeport, Ct., for several years and now prompted by the demand above referred to and profiting by their experience with the smaller sizes, they have recently brought out a large machine for automatically threading screws and worms up to 10 inches in diameter. This machine, which is similar in its general features to the engine lathe, partakes in general of the design of the smaller machines that

have been built by the company, but with such additions as are made necessary by the increased size of the work which is handled. The cut shows a back view of the machine, giving a very good idea of the automatic mechanism and the extra heavy gears that have been provided both for the drive and feed incidental to the increased duty of the machine. The lead screw is located in the center of the bed and as near to the work as possible. The carriage carries four threading tools, which are held in blocks in such a manner that they may be quickly removed, sharpened and replaced without affecting the accuracy of their position. One of these tools is used for roughing, two for siding (thus permitting the use of angular or shearing cutting edges), and one for finishing. The cut feed is graduated so that the last few passes of the tool over the work are with finishing or scraping chips, thus insuring an extreme smoothness of finish.

Fig. 2 shows a few samples of the work done on this lathe. The largest worm shown is 8 inches in diameter, 6 inches long, 6-inch lead, quadruple thread, 15-16 inch deep; this was threaded in 93 minutes. The next smaller worm is 3½ inches in diameter, 6 inches long, 1¾-inch lead, single thread, 1⅛ inch deep, and is peculiar in that the threaded portion is between flanges. Time for threading this worm, 74 minutes.

COMBINATION CALIPER SQUARE, DEPTH GAGE AND STEEL RULES.

The Billings & Spencer Co., Hartford, Conn., have recently placed on the market the combination tool shown in the accompanying illustration. An ordinary 5-inch steel rule is drilled and slotted at one end so that a small clamp may be readily attached. A 2-inch rule placed under this clamp is held squarely across the end of the larger rule. Sliding on this larger rule is a caliper jaw which in conjunction with the small rule makes a convenient caliper square. By removing the 2-inch rule and its clamp, and using only the sliding



Combination Caliper and Steel Rules.

jaw on the large scale, the tool is at once converted into a depth gage. In fact, two depth gages are obtainable, for if the sliding jaw be removed the short scale may be employed as a depth gage by using the larger rule as a base and sliding the small rule through the end clamp. This is often convenient for use in holes or slots that are too small for the large rule to be inserted. The tool is very handy for machinists and toolmakers, combining, as it does, the two above tools and at the same time providing two ordinary rules for general use when neither the caliper or depth gage is required.

PERSONAL.

Mr. E. R. Markham, well known to our readers as the author of the series of articles on the treatment of steel, has resigned his position in the Mechanic Arts High School, Springfield, Mass., to accept one with the J. H. Williams Co., Brooklyn, N. Y., beginning March 1st. Mr. Markham has had 25 years' shop experience. He served an apprenticeship under his father, Russell Markham, who for 40 years was in charge of the machine department of the Lamb Knitting Machine Co. Then he was diemaker with the Barney & Berry Skate Co., and with the Faye Tool Co., both of Springfield, Mass. Later on he took charge of the fine tool department and of the milling work on guns, etc., at the J. Stevens Arms & Tool Co., where he remained for eight years, leaving them to take charge of the machine department at the Lamb Knitting Machine Co., makers of the Spalding bicycles. Here he was shortly given charge of the hardening, the small parts and the grinding departments. Later he took charge of the tool department, where it was his duty not only to superintend the making of tools, but also to design all tools, jigs, fixtures and special machinery made in the shop. The method used by him for hardening the gears was adopted by several of the largest concerns making chainless bicycles. After five years with this firm, he went to the Waltham Watch Tool Co., as superintendent, and from there to the Mechanics Arts High School.

* * *

OBITUARY NOTE.

James Oscar Nixon, late engineer and manager of the silent-chain department of the Link-Belt Engineering Co., Philadelphia, died on December 27, 1902, aged 23 years. Mr. Nixon had already achieved a marked success in his work and gave every promise of a most successful career. He was a native of New Orleans and a graduate of Tulare University of that city. Mr. Nixon had been in the employ of the Link-Belt Engineering Co. three years, during which he showed that he possessed great mechanical genius. He was the author of the article on the Renold chain, which was published in MACHINERY, in the December issue.

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FRESH FROM THE PRESS.

ELEMENTS OF ELECTRICAL ENGINEERING. A first year's course for students. By Tyson Sewell, A. I. E. E. 332 pages, size 5¼ x 8 inches. Illustrated with 204 cuts. Published by Crosby Lockwood & Son, London, and D. Van Nostrand Co., New York. Price $3.00 net.

This excellent work is based upon courses of lectures given by Prof. Sewell to students at the Polytechnic, Regent St., London, who were qualifying as electrical engineers. The treatment of the subject is as non-mathematical as the nature of the science will permit, and still give a student a substantial groundwork for the advanced work necessary to the degree of electrical engineer. The book is divided into sixteen chapters, the first being, of course, an exposition of Ohm's law, which is the fundamental principle of electrical science. The explanation employs the hydraulic analogy in which the flow of water in a closed pipe system is compared to the flow of the electric current in a circuit. A pump in the pipe system, which causes the water to circulate round and round, corresponds to the electric generator or dynamo. The succeeding chapters take up in order: Units employed in electrical engineering; series and parallel circuits; heating effect of the electric current; the magnetic effect of the electric current; the magnetization of iron; primary batteries and accumulators; ammeters, voltmeters and ohmmeters; electric meters; electric measuring instruments; electric measurements; arc lamps; incandescent lamps; continuous current generators; and direct-current motors. The work is one that we believe will be highly appreciated by many young men who are looking for a sound treatise on electricity that will give them something more than the bare fundamental principles, and yet written so as to come within the range of ordinary mathematical comprehension. A careful study of the book will, in our opinion, furnish a good working knowledge of electricity and one that no one beneath the rank of electrical engineer, need be ashamed of.

HARDENING, TEMPERING, ANNEALING AND FORGING OF STEEL. By Joseph V. Woodworth. Published by Norman W. Henley & Co., 132 Nassau St., New York. 288 pages. Illustrated. Price, $2.50.

This volume by Mr. Woodworth takes up in its various chapters the selection of steel, its annealing, hardening, tempering, and case-hardening, as indicated by the title, with supplementary chapters upon miscellaneous methods used in metal-working such as forging and welding, grinding tools, etc. The author had in view the preparation of a volume treating this subject in a practical manner, and was led to prepare the work from the fact that there is very little published information upon the subject outside of the technical press. Unlike Mr. Woodworth's book, "Dies, their Construction and Use," which we reviewed last month, this work is largely a compilation and contains a great number of items that have been gathered from various sources and systematically arranged. These have been taken mainly from the leading technical papers or have been obtained from master mechanics or others connected with machine shop work, and from catalogues. While the book is fully illustrated the cuts are mainly from catalogues, so that its general appearance is not as good as that of "Dies, their Construction and Use." It appears to be carefully arranged, however, and contains many notes and data that would be of assistance to any mechanic.